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ARCHITECTURE

ENGINEERING

DECORATION

CONSTRUCTION

TICKNOR & COMPANY

BOSTON MASS.

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THE SANITAS

PATENT

KITCHEN SINK AND FLUSH-POT

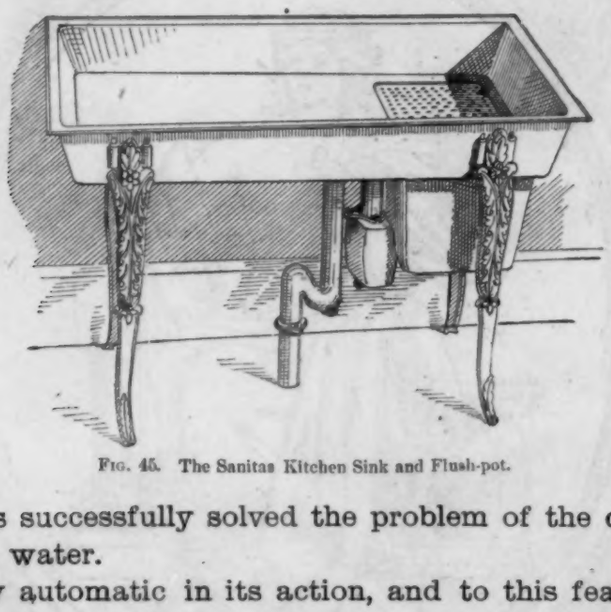

FIG. 45. The Sanitas Kitchen Sink and Flush-pot.

This device has successfully solved the problem of the disposal of kitchen and pantry waste water.

It is absolutely automatic in its action, and to this feature is largely due its great success.

It is so constructed that it must always do its work correctly and completely and it ***cannot be made to do otherwise***, even by the greatest ignorance or neglect on the part of the user. It operates on the principle of the intermittent automatic flush tank, keeps the waste pipes clean, and obviates the necessity of using a grease trap. It is provided with an accessible seal-retaining trap constructed on the principle of the Sanitas Trap, and is altogether the only complete sanitary Kitchen Sink ever offered to the public.

SANITAS MFG. CO., 207 Tremont St., Boston, Mass.

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EVER since the close of the competition for the Cathedral of St. John the Divine we have been more or less occupied in an endeavor to bring about the publication of the competitive designs in large folio form, and in a style of book-making commensurate with the dignity of the occasion. But we have found that there was so great a diversity of opinion amongst the competitors as to how and when their designs should be laid before the public that we have been forced to abandon the scheme of making an elaborate special publication. But what is a loss to the few who would have paid for the more expensive work will prove a gain to some of our subscribers, since we have decided to publish in several enlarged issues of the Imperial Edition a selection from the designs submitted, and, though less satisfying than if shown at a larger scale, we believe that very little will be sacrificed to the exigencies of the situation. The first of these special issues will be made on Saturday, October 5, and, as is always the case with special issues, the retail price will be increased. This intimation is thrown out merely for the benefit of the occasional public, since, of course, our subscribers reap the benefit, without extra charge, of any additional attraction that their own cordial support enables us to lay before them from time to time.

THE younger part of the profession in Boston has met with a severe loss in the death of Mr. Ernest G. Hartwell, who was accidentally drowned this week while endeavoring, with a companion, to sail out in stormy weather in a small boat to reach a yacht which was waiting for them. Mr. Hartwell was the only son of Mr. Henry W. Hartwell, one of the best-known architects in the country, and was a junior in his father's office. He had been very thoroughly trained for his profession, and gave promise of a brilliant future. After graduating with distinction from the four years' course in architecture at the Massachusetts Institute of Technology, with the degree of Bachelor of Science, he spent some time in the office of Messrs. Hook & Hastings, organ-builders, in Boston, where he was able to acquire a valuable knowledge of a special department of professional work, and at the same time increase his knowledge of music, of which he was passionately fond. He then began regular work in his father's office, where he continued, as an able and trusted assistant, until his death, allowing himself only one long vacation of something more than a year, which he spent abroad in sketching and studying with characteristic energy. Among the young architects and draughtsmen of the city Mr. Hartwell was a greatly respected and popular companion. He was an officer of the Boston Architectural Club and a leader in several musical associations.

THERE is a good deal of talk in France just now about forming a company to insure architects against loss through the responsibility which the law imposes upon them for the security of the buildings which they design, and it seems quite probable that the idea may be carried out. The French law is much more fair to architects than ours. The foundation of the jurisprudence on the subject is the article in the Code Napoléon, which says that "if a building perishes, either wholly or in part, from vices in construction, even from defects in the ground on which it stands, the builder and architect shall be jointly responsible for ten years," but at present, this article is always interpreted so as to apportion the fault between the architect and contractor in something like a fair ratio, the architect being regarded as responsible for a "grave fault" only if his plans are proved to have been so ignorantly or carelessly made that the defects were the natural consequence of carrying them out, and only for a "light fault" if they proceed from the improper workmanship or materials furnished by the contractor, even though the architect may have supervised the workmanship, and seen the materials used without objection; while the contractor's liability is, so to speak, the reciprocal of that of the architect. The idea which prevails here, that the architect guarantees the fidelity of all contractors, including any rascals that his client may see fit to employ, and that, if his client is cheated by them, he must make good the loss, while the cheaters keep the money, although now entirely obsolete in the French courts, still makes its appearance occasionally among pig-headed laymen, and seems to have once prevailed among judges. The most celebrated case under the old interpretation of the law, and, perhaps, the one which, by its obvious cruelty and injustice, led to the modern device of separating the architect's liability into two sorts — one for "fautes lourdes," due to his incompetence or carelessness in preparing the plans, and the other for "fautes legères," consisting in negligent supervision of the work or materials furnished by the contractor — is that of Gauthier, the architect of the hospital of Lariboisière. Gauthier, as the designer of this celebrated building, gained the highest reputation throughout Europe. He was elected one of the "forty immortals" of the Institute of France, and was made by the Government an officer of the Legion of Honor. Long after the completion of Lariboisière, the city of Troyes, Gauthier's native place, undertook to build a hospital, and nothing would satisfy the citizens but to have their illustrious compatriot make the plans. They were made and sent to Troyes, tenders invited, and the contract awarded to the lowest bidder. Gauthier made as many visits to the work as Parisian architects generally did to buildings out of town, but, not being endowed, any more than the rest of us, with the gift of seeing what defects existed in the middle of a mass of masonry which was all covered up before he arrived, the contractor succeeded in concealing a large amount of bad workmanship. After the building was done, the contractor's tricks began to show their natural effect in settlements, cracks and other disorders. The town claimed damages from the contractor, who immediately failed, and it then laid hold of Gauthier under the code, which, as interpreted at that time, made him jointly (*solidairement*) responsible with the contractor. The case was decided against the unfortunate architect, who was condemned to pay forty thousand dollars to make good another man's intentional frauds, which he could not have detected or prevented, even if he had given up his own proper business to try to do so. Gauthier could not pay the money, any more than the contractor could, but, instead of allowing him, like the contractor, to make an assignment of his ostensible property, and then go off to live comfortably on the judiciously concealed profits of his tricks, his fellow-townsmen pursued him until, having secured what property he possessed, they had him dragged to the debtor's prison at Clichy, where he remained until his death, in 1858.

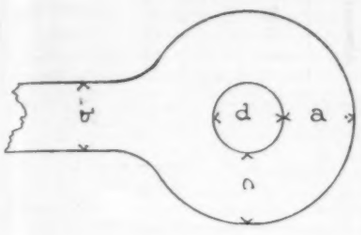
AT the International Congress of Hygiene, held in connection with the Exposition at Paris this year, MM. Emile Trélat and Somasco presented a paper on the warming and ventilation of dwelling-houses, which contains some new

suggestions. In their view, as in that of Mr. Leeds, the oldest of the American ventilating engineers, the perfection of comfort in artificial heating is to be secured by having the walls of the rooms warmed, while the air in them is kept comparatively cool and fresh; but they go much further than Mr. Leeds in the application of the principle. In houses managed as they would have them, all the artificial warmth enjoyed by the occupants should be radiated from the walls, and from the other objects in the room, which are themselves warmed by the radiation from the walls, and the air in the rooms should be taken directly from out-of-doors, even in the coldest weather, by openings as numerous and varied as possible, so as not to cause objectionable draughts. Naturally, the French idea of a draught is different from that which prevails in our climate, and MM. Trélat and Somasco think it would be an excellent arrangement to have all rooms provided with windows on two opposite sides, which should be kept open "whenever the weather would permit," while in "half-cold" weather a single pane, or portion of the windows only need be opened, and in the dead of winter it would be sufficient to introduce air through sheets of glass "perforated with numerous small conical holes," which would be in general "permanently open," but might be closed during tempests and snowstorms. Besides these windows, they think there should be openings "in various parts of the walls, as high up as possible." Notwithstanding all that has been said about this system of warming houses, we do not know that it has ever been tried, at least in this country, and, with our facility in the use of steam and hot-water pipes, it is rather curious that no one should have made the experiment. Mr. Leeds used to compare such heating with the exhilarating effect of an open wood-fire in a cool room, but it would be impracticable to warm the walls of a room so as to give out anything like the radiation of a fire, and we are inclined to think that for our winter days it would be necessary to close the ventilators long enough to allow the air in the rooms to become warmed by convection about to the point at present customary. As we have all experienced, a person exposed to severe cold out-of-doors is obliged to resist its effects by an effort, partly muscular and partly nervous. It is a common saying, that one can warm himself in a cold day by taking long breaths, and keeping his lungs inflated as long as possible, and a certain effort of the will assists in preventing the body from yielding to a chill, but either sort of exertion is fatiguing, and when it is over, it is necessary to relieve the body by remaining for a time in the atmosphere much warmer than would be comfortable at ordinary times. The Esquimaux pass their nights in an excessively warm, close atmosphere, inside their snow-huts, where the conditions are the reverse of those which the advocates of the new system consider desirable, but they can come out the next morning and hunt bears all day, with the thermometer at sixty below zero. MM. Trélat and Somasco have another idea, which is certainly an excellent one, about the importance of porous walls. According to statistics which they mention, it is found that in districts where houses are built of soft limestone, and other permeable materials, the walls inside are bright and fresh, and the air pure, while in the countries where granite, gneiss, slate or hard sandstone are the building materials, the walls, impervious to air, are damp and stained with condensation inside, and the rooms are foul-smelling and unwholesome. This agrees with the experience of the Massachusetts State Board of Health, which found that consumption was most prevalent among people who lived in stone houses; that brick houses harbored fewer cases in proportion, and wooden houses least of all; and with the facts reported by Pettenkofer, who found that in brick houses about one-half the air entering the rooms from all sources came through the walls; and an architect who can persuade a client to build a house with porous, aerated walls, or who will try the experiment himself, may be able to render an important service to the science of hygiene.

SIGNOR MELANI writes to *La Construction Moderne* some curious bits of history in regard to the dome of the Cathedral of Florence. Of course, Brunelleschi is agreed on all hands to have been the person principally concerned in the construction of the dome, but it has recently been claimed that the design belonged to a previous period, and that in its execution other persons were associated with Brunelleschi, with authority nearly or quite equal to his. The fact seems to be that Arnolfo da Cambio left a design for the dome, as well as the rest of the church, and the work went on after his death substantially in accordance with his scheme, until the nave and a portion of the apses were completed. Then the design was thoroughly examined, under whose direction is not certain, and important modifications made in the arrangement of the dome, and the construction of the semi-domes over the apses. An elaborate model of the whole, in masonwork, was made in accordance with the new ideas, and for many years afterwards every one who took part in the work, including even the bricklayers, was compelled to take an oath to conform to the model. This official model seems to have been made in 1367, and up to 1407, forty years later, when five of the apsidal chapels had been finished, the model appears to have been strictly followed. In 1421 the other three apsidal chapels were completed, but meanwhile there seems to have been a question about the resistance of the arches by which the chapels open into the space beneath the dome, and there is some reason to suppose that the octagonal drum, with its circular windows, was carried up at that time as a constructional expedient for loading the arches beneath, without authority from the model, and that Brunelleschi found it nearly completed when his connection with the work began. Beyond the drum of the dome the authorities of the church seem to have had no ideas whatever, a circumstance which goes to confirm the surmise that the model had been abandoned before the drum was built; and in 1418 they called upon all persons who had any projects or models in regard to the completion of the dome to present them before a certain date. Brunelleschi, who had been for some time thinking over the problem as an amateur, got Donatello, and a certain Nanni di Banco, to help him, and the three made a small dome of brick and mortar, without centering, which they presented for competition. Ghiberti, who, like Brunelleschi, was a goldsmith of unusual energy, also appeared as a competitor, with not one, but several model domes, one of which was put together with masonry, much in the same way as that of Brunelleschi and his friends. What might have been the other plans submitted we do not know, but it is certain that the church authorities were equally pleased with those of Ghiberti and Brunelleschi, and solved the competition, with the usual tact of lay judges, by appointing them joint architects of the dome. Donatello and Nanni thereupon disappeared from the scene, and both Brunelleschi and Ghiberti are shown by the records to have drawn salaries as architects of the dome until 1425, when Ghiberti, who had just been commissioned to execute the second door of the Baptistery, resigned his place at the cathedral, and Brunelleschi reigned as sole architect until his death in 1446. How much Ghiberti contributed toward the design of the dome it would be hard to say. The story is that Brunelleschi found him a mere incumbrance, and tried successfully to drive him off by pretending to be ill at a critical point in the construction, so as compel him to show his ignorance, which he did by building something which had to be torn down; but there is no hint in the records of any demolition or rebuilding of any part of the work, and Ghiberti had a good reason for resigning to devote himself to his second "Gate of Paradise," while the fact that he had been actively engaged at the cathedral for seven years indicates that his efforts were satisfactory while they lasted.

THE color of the Eiffel tower has been one of the puzzles of the Paris Exposition, no two persons agreeing as to what the real color is. Some people imagine that it has been plated with nickel or silver, while others call it red, and others again think that it is of a beautiful bronze color. The fact is that it is painted in five shades of the same color, modulated with the skill that the French often show in cases of the kind. From the base to the first platform, the color is a dark "Barbedienne" bronze, verging a little to red; thence to the second platform the color is the same, but lighter, and from this point to the top the color grows constantly lighter, by five successive gradations, the top being almost a golden yellow. Three coats of paint are spread over the entire surface, and over all is a coat of very hard, transparent varnish, which, by reflecting the sun, adds to the difficulty of defining the color with precision. The varnish is a new, patent compound, we believe, but it is said to have borne the severe test of use on the ironwork of the tower extremely well.

SAFE BUILDING.[1]—XXXIV.



WHEN a strain on a beam is never completely removed, but changes constantly from a larger to a smaller strain, both however in the same direction, the effect is not so great as where both strains are at times constantly removed.

In such cases the effect can be found from the following Formula:

Variable Strains. $$w = (w_i - w_{ii}) \cdot x + w_{ii} \qquad (106)$$

Where w = the corresponding dead load, or constant strain in pounds, per square inch, to produce the same effect as one alternating between two unequal loads or strains w_i and w_{ii}, but both in the same direction.

Where w_i = the larger of the alternating loads or strains, in pounds, per square inch.

Where w_{ii} = the smaller of the alternating loads or strains, in pounds, per square inch.

Where $x = 3{,}0$ for cast-iron, and $= 1\frac{1}{2}$ for wrought-iron and mild-steel.

The above condition would frequently happen in the case of warehouse floors, bridges, and other places where there is a constant dead load, which at times is increased by other loads to be carried.

If the additional load is put on suddenly, or is a moving load, it should be doubled. In that case w_i would be equal to the doubled dynamic load plus the static load, and w_{ii} would be equal to the static load.

In all designs of metal structures great care should be taken to design all parts, not only of practicable shapes and sizes, but of dimensions that will not involve increased cost.

Economical Designing. As a rule cast-iron, wrought-iron and steel are estimated at a certain price per pound. If the sizes are not unusually small nor unusually large the price will be the usual one. If, however, the sizes are very light the price will be greatly increased, for two reasons. The cost of preparatory work, working drawings, office expenses, models, etc., will be practically the same as for heavier work; the handling and labor will be very nearly the same, and in very light construction all this must be borne by fewer pounds and the price is consequently greater. On the other hand, if the pieces are unusually heavy, or large, or long, they may require special rolling or casting, and may require special

TABLE XXXIII.

PROPORTIONS FOR SCREW THREADS, NUTS, and BOLT HEADS.

Diameter of Screw.	Threads per Inch.	Diameter at root of Thread.	Width of Flat.	Short Diameter Rough.	Short Diameter Finish.	Long Diameter Rough.	Long Diameter Rough.	Thickness Rough.	Thickness Finish.	Short Diameter Rough.	Short Diameter Finish.	Long Diameter Rough.	Long Diameter Rough.	Thickness Rough.	Thickness Finish.
.. ¼ ..	.. 20 ..	,185	,0062	.. ½ ..	.. ⅝ ..	.. ⅝ ..	.. ⅝ ..	.. ¼ ..	.. ¼ ..	.. ½ ..	.. ⅝ ..	.. ⅝ ..	.. ⅝ ..	.. ¼ ..	.. ¼ ..
.. 5/16 ..	.. 18 ..	,240	,0074	.. ⅝ ..	.. ⅝ ..	.. ⅝ ..	.. ⅝ ..	.. 5/16 ..	.. 5/16 ..	.. ⅝ ..	.. ⅝ ..	.. ⅝ ..	.. ⅝ ..	.. 5/16 ..	.. 5/16 ..
.. ⅜ ..	.. 16 ..	,294	,0078	.. ⅝ ..	.. ⅝ ..	.. ⅝ ..	.. ⅝ ..	.. ⅜ ..	.. ⅜ ..	.. ⅝ ..	.. ⅝ ..	.. ⅝ ..	.. ⅝ ..	.. ⅜ ..	.. ⅜ ..
.. 7/16 ..	.. 14 ..	,344	,0089	.. ⅝ ..	.. ⅝ ..	.. ⅝ ..	.. 1 ..	.. 7/16 ..	.. 7/16 ..	.. ⅝ ..	.. ⅝ ..	.. ⅝ ..	.. 1 ..	.. 7/16 ..	.. 7/16 ..
.. ½ ..	.. 13 ..	,400	,0096	.. ⅝ ..	.. ⅝ ..	.. 1 ..	.. 1⅛ ..	.. ½ ..	.. ½ ..	.. ⅝ ..	.. ⅝ ..	.. 1 ..	.. 1⅛ ..	.. ½ ..	.. ½ ..
.. 9/16 ..	.. 12 ..	,454	,0104	.. ⅞ ..	.. ⅞ ..	.. 1⅛ ..	.. 1⅛ ..	.. 9/16 ..	.. 9/16 ..	.. ⅞ ..	.. ⅞ ..	.. 1⅛ ..	.. 1⅛ ..	.. 9/16 ..	.. 9/16 ..
.. ⅝ ..	.. 11 ..	,507	,0113	.. 1 ..	.. 1 ..	.. 1¼ ..	.. 1¼ ..	.. ⅝ ..	.. ⅝ ..	.. 1 ..	.. 1 ..	.. 1¼ ..	.. 1¼ ..	.. ⅝ ..	.. ⅝ ..
.. ¾ ..	.. 10 ..	,620	,0125	.. 1⅛ ..	.. 1⅛ ..	.. 1⅜ ..	.. 1⅜ ..	.. ¾ ..	.. ¾ ..	.. 1⅛ ..	.. 1⅛ ..	.. 1⅜ ..	.. 1⅜ ..	.. ¾ ..	.. ¾ ..
.. ⅞ ..	.. 9 ..	,731	,0138	.. 1⅜ ..	.. 1⅜ ..	.. 1½ ..	.. 2⅛ ..	.. ⅞ ..	.. ⅞ ..	.. 1⅜ ..	.. 1⅜ ..	.. 1½ ..	.. 2⅛ ..	.. ⅞ ..	.. ⅞ ..
.. 1 ..	.. 8 ..	,837	,0156	.. 1⅛ ..	.. 1⅛ ..	.. 1½ ..	.. 2⅛ ..	.. 1 ..	.. 1 ..	.. 1⅛ ..	.. 1⅛ ..	.. 1½ ..	.. 2⅛ ..	.. 1 ..	.. 1 ..
.. 1⅛ ..	.. 7 ..	,940	,0178	.. 1⅜ ..	.. 1⅜ ..	.. 2 ..	.. 2⅛ ..	.. 1⅛ ..	.. 1⅛ ..	.. 1⅜ ..	.. 1⅜ ..	.. 2 ..	.. 2⅛ ..	.. 1⅛ ..	.. 1⅛ ..
.. 1¼ ..	.. 7 ..	1,065	,0178	.. 2 ..	.. 1⅜ ..	.. 2 ..	.. 2⅛ ..	.. 1¼ ..	.. 1¼ ..	.. 2 ..	.. 1⅜ ..	.. 2 ..	.. 2⅛ ..	.. 1 ..	.. 1¼ ..
.. 1⅜ ..	.. 6 ..	1,160	,0208	.. 2⅛ ..	.. 2⅛ ..	.. 2⅛ ..	.. 3⅛ ..	.. 1⅜ ..	.. 1⅜ ..	.. 2⅛ ..	.. 2⅛ ..	.. 2⅛ ..	.. 3⅛ ..	.. 1⅜ ..	.. 1⅜ ..
.. 1½ ..	.. 6 ..	1,284	,0208	.. 2⅜ ..	.. 2⅛ ..	.. 2⅜ ..	.. 3⅛ ..	.. 1½ ..	.. 1½ ..	.. 2⅜ ..	.. 2⅛ ..	.. 2⅜ ..	.. 3⅛ ..	.. 1½ ..	.. 1½ ..
.. 1⅝ ..	.. 5½ ..	1,389	,0227	.. 2⅜ ..	.. 2⅜ ..	.. 2⅜ ..	.. 3⅜ ..	.. 1⅝ ..	.. 1⅝ ..	.. 2⅜ ..	.. 2⅜ ..	.. 2⅜ ..	.. 3⅜ ..	.. 1⅝ ..	.. 1⅝ ..
.. 1¾ ..	.. 5 ..	1,491	,0250	.. 2½ ..	.. 2½ ..	.. 3 ..	.. 3½ ..	.. 1¾ ..	.. 1¾ ..	.. 2½ ..	.. 2½ ..	.. 3 ..	.. 3½ ..	.. 1¾ ..	.. 1¾ ..
.. 1⅞ ..	.. 5 ..	1,616	,0250	.. 2⅝ ..	.. 2⅝ ..	.. 3⅛ ..	.. 4⅛ ..	.. 1⅞ ..	.. 1⅞ ..	.. 2⅝ ..	.. 2⅝ ..	.. 3⅛ ..	.. 4⅛ ..	.. 1⅞ ..	.. 1⅞ ..
.. 2 ..	.. 4½ ..	1,712	,0277	.. 3⅛ ..	.. 3⅛ ..	.. 3¾ ..	.. 4⅜ ..	.. 2 ..	.. 1⅛ ..	.. 3⅛ ..	.. 3⅛ ..	.. 3¾ ..	.. 4⅜ ..	.. 1⅞ ..	.. 1⅛ ..
.. 2¼ ..	.. 4½ ..	1,962	,0277	.. 3⅜ ..	.. 3⅞ ..	.. 4⅛ ..	.. 4⅜ ..	.. 2¼ ..	.. 2⅜ ..	.. 3⅜ ..	.. 3⅞ ..	.. 4⅛ ..	.. 4⅜ ..	.. 1½ ..	.. 2⅛ ..
.. 2½ ..	.. 4 ..	2,176	,0312	.. 3⅞ ..	.. 3⅛ ..	.. 4½ ..	.. 5⅛ ..	.. 2½ ..	.. 2⅞ ..	.. 3⅞ ..	.. 3⅛ ..	.. 4½ ..	.. 5⅛ ..	.. 1⅝ ..	.. 2⅞ ..
.. 2¾ ..	.. 4 ..	2,426	,0312	.. 4⅛ ..	.. 4⅛ ..	.. 4⅝ ..	.. 6 ..	.. 2¾ ..	.. 2⅞ ..	.. 4⅛ ..	.. 4⅛ ..	.. 4⅝ ..	.. 6 ..	.. 2⅛ ..	.. 2⅞ ..
.. 3 ..	.. 3½ ..	2,629	,0357	.. 4⅜ ..	.. 4⅜ ..	.. 5⅛ ..	.. 6⅛ ..	.. 3 ..	.. 2⅛ ..	.. 4⅜ ..	.. 4⅜ ..	.. 5⅛ ..	.. 6⅛ ..	.. 2⅛ ..	.. 2⅛ ..
.. 3¼ ..	.. 3½ ..	2,879	,0357	.. 5 ..	.. 4⅛ ..	.. 5⅛ ..	.. 7⅛ ..	.. 3¼ ..	.. 3⅛ ..	.. 5 ..	.. 4⅛ ..	.. 5⅛ ..	.. 7⅛ ..	.. 2¼ ..	.. 3⅛ ..
.. 3½ ..	.. 3½ ..	3,100	,0384	.. 5⅛ ..	.. 5⅛ ..	.. 6⅛ ..	.. 7⅛ ..	.. 3½ ..	.. 3⅛ ..	.. 5⅛ ..	.. 5⅛ ..	.. 6⅛ ..	.. 7⅛ ..	.. 2½ ..	.. 3⅛ ..
.. 3¾ ..	.. 3 ..	3,317	,0413	.. 5⅛ ..	.. 5⅛ ..	.. 6⅛ ..	.. 8⅛ ..	.. 3¾ ..	.. 3⅛ ..	.. 5⅛ ..	.. 5⅛ ..	.. 6⅛ ..	.. 8⅛ ..	.. 2⅛ ..	.. 3⅛ ..
.. 4 ..	.. 3 ..	3,567	,0413	.. 6⅛ ..	.. 6⅛ ..	.. 7⅛ ..	.. 8⅛ ..	.. 4 ..	.. 3⅛ ..	.. 6⅛ ..	.. 6⅛ ..	.. 7⅛ ..	.. 8⅛ ..	.. 3⅛ ..	.. 3⅛ ..
.. 4¼ ..	.. 2¾ ..	3,798	,0435	.. 6⅛ ..	.. 6⅞ ..	.. 7⅛ ..	.. 9⅛ ..	.. 4¼ ..	.. 4⅛ ..	.. 6⅛ ..	.. 6⅞ ..	.. 7⅛ ..	.. 9⅛ ..	.. 3⅛ ..	.. 4⅛ ..
.. 4½ ..	.. 2¾ ..	4,028	,0454	.. 6⅛ ..	.. 6⅛ ..	.. 7⅛ ..	.. 9⅛ ..	.. 4½ ..	.. 4⅛ ..	.. 6⅛ ..	.. 6⅛ ..	.. 7⅛ ..	.. 9⅛ ..	.. 3⅛ ..	.. 4⅛ ..
.. 4¾ ..	.. 2¾ ..	4,256	,0476	.. 7⅛ ..	.. 7⅛ ..	.. 8⅛ ..	.. 10⅛ ..	.. 4¾ ..	.. 4⅛ ..	.. 7⅛ ..	.. 7⅛ ..	.. 8⅛ ..	.. 10⅛ ..	.. 3⅛ ..	.. 4⅛ ..
.. 5 ..	.. 2½ ..	4,480	,0500	.. 7⅛ ..	.. 7⅛ ..	.. 8⅛ ..	.. 10⅛ ..	.. 5 ..	.. 4⅛ ..	.. 7⅛ ..	.. 7⅛ ..	.. 8⅛ ..	.. 10⅛ ..	.. 3⅛ ..	.. 4⅛ ..
.. 5¼ ..	.. 2½ ..	4,730	,0500	.. 8 ..	.. 7⅛ ..	.. 9⅛ ..	.. 11⅛ ..	.. 5¼ ..	.. 5⅛ ..	.. 8 ..	.. 7⅛ ..	.. 9⅛ ..	.. 11⅛ ..	.. 4 ..	.. 5⅛ ..
.. 5½ ..	.. 2½ ..	4,953	,0526	.. 8⅛ ..	.. 8⅛ ..	.. 9⅛ ..	.. 11⅛ ..	.. 5½ ..	.. 5⅛ ..	.. 8⅛ ..	.. 8⅛ ..	.. 9⅛ ..	.. 11⅛ ..	.. 4⅛ ..	.. 5⅛ ..
.. 5¾ ..	.. 2½ ..	5,203	,0526	.. 8⅛ ..	.. 8⅛ ..	.. 10⅛ ..	.. 12⅛ ..	.. 5¾ ..	.. 5⅛ ..	.. 8⅛ ..	.. 8⅛ ..	.. 10⅛ ..	.. 12⅛ ..	.. 4⅛ ..	.. 5⅛ ..
.. 6 ..	.. 2½ ..	5,423	,0555	.. 9⅛ ..	.. 9⅛ ..	.. 10⅛ ..	.. 12⅛ ..	.. 6 ..	.. 5⅛ ..	.. 9⅛ ..	.. 9⅛ ..	.. 10⅛ ..	.. 12⅛ ..	.. 4⅛ ..	.. 5⅛ ..

Rough Nut—one and one-half diameter of bolt + ⅛.

Finished Nut—one and one-half diameter of bolt + 1/16.

Rough Nut—diameter of bolt.

Finished Nut—diameter of bolt—1/16.

Rough Head—one and one-half diameter of bolt + ⅛.

Finished Head—one and one-half diameter of bolt + 1/16.

Rough head—one-half distance between parallel sides of head.

Finished head—diameter of bolt—1/16.

[1] Continued from page 110, No. 715.

cars and freight arrangement, special trucks, derricks, etc., or they may be very difficult to manufacture and involve much loss, many misgoes, etc.

The architect should, therefore, as far as possible design so as to use standard sizes.

In castings as well as in millwork the standard will vary more or less with the parties doing the work. It will be impossible, therefore, to give here any universal standard. A few hints, however, may help the architect in economical designing.

Thickness of Columns. For hollow-castings (columns) Planat gives the following as the French standard, the thicknesses being the *minimum* or *smallest* thickness possible for the length.

For columns 6′ 6″ long not less than $\frac{3}{8}$″ thick
For columns 9′ 10″ long not less than $\frac{1}{2}$″ thick
For columns 13′ 1″ long not less than $\frac{5}{8}$″ thick
For columns 19′ 8″ long not less than $\frac{3}{4}$″ thick
For columns 26′ 2″ long not less than 1″ thick

The practice of American ironworks is to regulate the thickness with the diameter rather than the length. Thus our iron-works make columns under 6″ diameter about $\frac{1}{2}$″ thick, those over 6″ diameter from $\frac{5}{8}$″ thick and upwards.

For castings made to carry weight the thickness should be more. In columns the maximum thickness should depend upon the possibility of making the core stiff enough to keep its place in the centre. Large diameter with thinner shell (within reasonable limits) will give the most strength for the amount of material used, thick castings being much weaker, as already shown.

Avoid great length. In rolled-work, beams, channels, tees, etc., of unusual length should be avoided. Most sections are rolled to 30 feet in length without extra charge; beyond this there is an additional charge per pound, for every extra five feet or fraction thereof in length, if the section is heavy, up to 40 or 50 feet which is the limit for beams and channels, or up to 90 feet for angles. Then, too, very long pieces (over 30 feet long) involve being carried on two cars, which means extra freight charges, and very heavy pieces might be refused by many railroads. Where great length is desired it will be better, as a rule, to make it up of two pieces, the extra material required for the "splicing" being, as a rule, much more economical than the cost of manufacturing and handling long and heavy pieces.

In pieced work where angles are attached to beams, etc., if it is punched and fitted together at the mill with bolts the whole will be charged at a standard rate per pound; if, however, the pieces are riveted together, there will be an extra charge on the whole, even if only one rivet were used.

If pieces are required to be cut to exact lengths there is usually an extra charge on the whole. If pieces are required to be drilled or punched, there is an extra charge on the whole, even if there is only one hole in each piece.

TABLE XXXIV.

Recent Tests of Irons and Steels.

Material.	Remarks.	Per Cent. of Carbon.	Per Cent. of Silicon.	Per Cent. of Manganese.	Modulus of Elasticity, in pounds—inch, for Tension.	Modulus of Elasticity, in pounds—inch, for Compression.	Modulus of Elasticity, in pounds—inch, for Cross-Breaking.	Tension, in pounds, per square inch. Elastic Limit.	Tension, in pounds, per square inch. Ultimate Stress, t.	Compression, in pounds, per square inch. Elastic Limit.	Compression, in pounds, per square inch. Ultimate Stress, c.	Ultimate Modulus of Rupture, per square inch, k.	Ultimate Shearing Stress, per square inch. g=across grain. g'=along grain.	Per Cent. of Elongation.	Per Cent. of Contraction of Area.	Number of tests averaged.	Authority.
Wrought Iron.	Different English Irons.	....	....	....	28560000	28985000	....	28500	56000	27600	.....	.....	.....	7,01 to 17,87	5,9 to 51,4	12	English Steel Committee
	" German "	TESTED IN SIX DIFFERENT DIRECTIONS ACROSS AND ALONG THE GRAIN.															Bauschinger
	American Tie Rod $3\frac{1}{4}$″d.							22865	48085				g=94 to 4500	2,4	2,2	2	Watertown Arsenal
	" " $\frac{1}{4}$″d.							32716	54416				g'=45 to 2900	21,0	42,4	3	
Wrought Steel.	10″ Channel	....	....	....	.....	.....	.....	44650	73675	39285	41390	.....	.....	23,6	43,3	2	Bauschinger
	$\frac{1}{2}$″ Rolled Plate	0,14	....	....	32000000	38250000	.....	42000	63000	39500	.....	.....	g=48000	21,8	49,2		
	" "	0,51	....	....	31450000	32500000	.....	48400	86000	40000	.....	.....	g=57000	14,3	25,1	12	
	" "	0,78	....	....	33550000	32450000	.....	53200	92000	53000	.....	.....	g=59000	11,4	19,1		
	" "	0,96	....	....	30900000	32700000	.....	69000	118000	71000	.....	.....	g=83000	6,6	10,0		
Cast, Crucible and Bessemer English Steels	Mean of 37 samples	....	....	....	29300000	30000000	.....	47600	88800	47000	.....	.....	.....	0,89 to 13,61	1,30 to 48,7	27	English Steel Committee
	Lowest (Bessemer)	....	....	....	28400000	29100000	.....	35840	74000	33600	.....	.....	.....				
	Highest (Cast)	....	....	....	29900000	31500000	.....	60480	123000	60480	.....	.....	.....				
American Steel.	Tubes for Rifled Cannon	....	....	....	.....	.....	.....	33 to 52000	58 to 91000	46 to 54000	83 to 104000	.....	.....	4,7 to 30	11,8 to 59,3	206	Watertown Arsenal
	8″ Rifled Cannon	....	....	....	.....	.....	.....	30 to 67000	74 to 115000	.....	.....	.....	.....	5,8 to 31	0 to 57	53	
Steel Wire.	Am. tinned wr. for Can'n	....	....	....	.....	.....	.....	....	160 to 181000	.....	.....	.....	.....	.....	8,4 to 21,8	13	
	Foreign wire "	....	....	....	.....	.....	.....	....	264 to 329680	.....	.....	.....	.....	.....	12,2 to 23,5	9	
Cast Steels.	Cast Steel, Open-Hearth	0,55	0,13	0,96	32000000	of phosphorus		35 to 48000	60 to 97440	39 to 45000	65 to 74800	134340	.....	2,0 to 18,0	1,5 to 30,6	93	Foster
	Averaged from 14 tests	0,33	0,23	0,62	.....	.....	.....	.....	74000	.....	.....	.....	.....	23	41	5	
		0,50	0,40	0,66	.....	.....	.....	.....	96000	.....	.....	.....	.....	9	12	3	
		0,77	0,46	0,67	.....	.....	.....	.....	85000	.....	.....	.....	.....	1,5	2	3	
		0,96	0,02	0,64	.....	.....	.....	.....	78000	.....	.....	.....	.....	1,33	1,6	3	
	American Steel	....	....	....	29130000	.....	24400000	29120	47264	28072	.....	24125	.....	0,4 to 29,9	.....	11	Abbott
Steel.	Bessemer Plates	TESTED IN SIX DIFFERENT DIRECTIONS ACROSS AND ALONG THE GRAIN.											g=53 to 6600 g'=47 to 6600				Bauschinger
Malleable Cast Iron.	Square $\frac{3}{4}$″	....	....	American	.....	.....	.....	1635	36176	.....	.....	.....	.....	3,8	5,8	2	Ricketts
	Rectangular 1″ × $\frac{3}{4}$″	....	....	"	.....	.....	.....	2979	34272	.....	.....	.....	.....	2,4	6,6	1	
	Circular $\frac{3}{4}$″ diameter	....	....	"	.....	.....	.....	2985	38676	.....	.....	.....	.....	3,5	10,0	1	
	" $\frac{3}{4}$″ "	....	....	"	.....	.....	.....	1456	31032	.....	.....	.....	.....	1,3	3,9	2	
	German	....	....	....	.....	.....	.....	9856	36736	.....	.....	.....	.....	2,5	8,2	..	Martens
Cast Iron.	American, average	....	....	....	.....	.....	.....	.....	17 to 30740	.....	48 to 54800	.....	.....	.....	.....	44	
	" $\frac{1}{2}$″ to 1″ thick	All undressed (with skin on,)			.....	.....	16453000	.....	.....	.....	.....	44680	.....	.....	.....	7	Watertown Arsenal
	" 1″ thick	the dressed ones (planed,) were			.....	.....	15468000	.....	.....	.....	.....	40640	.....	.....	.....	1	
	" 1″ to 2″ thick	found to be slightly stronger			.....	.....	15296000	.....	.....	.....	.....	37932	.....	.....	.....	5	
	" 2″ thick	and results more regular.			.....	.....	13767000	.....	.....	.....	.....	36600	.....	.....	.....	2	

For these reasons it is usual where there is much fitting, drilling, etc., to be done to have it done at the mill for the standard rate per pound. Where, however, there is only a little to be done, as is usually the case in building construction, it is cheaper to do it at the building, using portable hydraulic punches or other similar contrivances to facilitate the labor.

Cost of Fitting.

A saving can also be made by doing all painting of heavy work at the building, as the mills charge a standard price per pound of metal for each coat; but where this is done, the architect cannot be too careful in having all rust removed.

In building up plate-girders, plates as wide as eight feet can be rolled, and of thickness and length in one piece not to exceed in finished weight two tons or four thousand pounds, this weight being about the limit for single pieces of rolled-work within reasonably economical limits.

Practicable Plate-sizes.

Thus, for instance, we could get plates five feet wide, one inch thick and twenty feet long, or eight feet wide, one-half inch thick and twenty-five feet long. If we require wider plates (usually for deep webs) we must take an eight-foot wide plate and shear it off, splicing the pieces. Thus if we required a ten-foot deep web, we would shear the eight-foot plate in ten-foot lengths, would place them side by side vertically, connecting them by covering plates of some kind, and our web would thus be composed of a series of panels each ten feet high and eight feet wide. Plates should not be over one inch thick on account of the difficulty of punching, nor less than one-quarter inch thick for fear of loss by rusting and failure by buckling. In steel plates, Carnegie, Phipps & Co., of Pittsburgh will roll plates up to 9′.6″ wide and 14′.2″ long, if about $\frac{1}{4}$″ thick, or 9′.2″ long by above width, if $1\frac{1}{4}$″ thick. See Table p. 51 in their hand-book of 1889.

In round, square and flat bars almost any sizes can be made, but, here too, unusually light or heavy ones are charged at extra rates.

The sizes of these vary with different mills, but are about as follows: The ordinary sizes for rounds and squares, are $\frac{3}{4}$″ to 2″ diameter, and for flats from 1″ to 4″ x $\frac{3}{8}$″ to $1\frac{1}{2}$″ and $4\frac{1}{2}$″ to 6″ x $\frac{3}{8}$″ to 1,″ these are made at regular rates.

Sizes of Rounds, Squares and Flats.

But the mills will make, at additional rates, rounds from wire sizes up to $\frac{3}{4}$″ diameter and from 2″ to 7″ diameter; half rounds from $\frac{3}{8}$″ to $1\frac{1}{4}$″ diameter; squares from $\frac{5}{16}$″ up to 5″; flats from $1\frac{1}{2}$″ x $\frac{5}{32}$″ up to 12″ x 2″.

In designing flats the best rule to follow is to make the thickness between one-fourth and one-third of the width, except for very wide bars, when it can be between one-eighth and one-quarter.

Where long bars are in tension, and one or both ends are held by nuts and screws, it is often economical to "up-set" the screw-ends, that is, enough material is added where the screw is cut, that is the diameter is enlarged enough at ends, to make the diameter at the root or thinnest part of the screw (that is between the threads), equal to the diameter of the whole bar. The screw itself is thus "upset," that is set upon the bar. The cost of upsetting screw-ends is more of course, than cutting screws upon ordinary bars, on account of the extra welding necessary, but in long bars, or very heavy bars, the material saved by not having to increase the diameter of the bar its whole length (to allow for cutting away at the ends), more than offsets the extra cost of up-setting. In light bars and short bars, as a rule, it is more economical to add enough to the diameter for the whole length to allow for cutting the thread at the end. In such a case the strength of the bar, in tension is, of course, only equal to the section at the root of the thread. It is a curious fact that threads cut with old dies are stronger than those cut with new dies; the old ones apparently crushing and thus leaving more material in the threads, while the new ones cut the material right out.

Up-set Screw-ends.

Different mills have different standards for threads, nuts, heads, etc. Practically, however, they all closely resemble the standards adopted by the Franklin Institute (of Philadelphia), February 17, 1866, and which are here reproduced by their permission as Table XXXIII.

Threads, nuts, etc.

In forming eye-bars the practice of different mills again varies.

It should be remembered that they are all welded, and therefore, if of wrought-iron, only some 80 per cent in strength of the metal in the bar. All parts should therefore be designed for some 25 per cent more strength than required with the usual factors-of-safety.

For ordinary sizes of flat iron the mills have dies on which these eyes are "die-forged," that is, formed by machinery. The Phœnix Co., for instance, have some fifty-six sizes of dies for flats varying from 2″ x $\frac{1}{2}$″ up to 6″ x $2\frac{1}{2}$″. The New Jersey Steel and Iron Works have some forty seven sizes of dies for flats from $2\frac{1}{2}$″ up to 6″. Their standards for pins are $\frac{1}{16}$″ less than even quarter-inches, as $2\frac{3}{16}$″ diameter, $2\frac{7}{16}$″, $2\frac{11}{16}$″, $2\frac{15}{16}$″, etc. All pin-holes in eye-bars should invariably be drilled, and should always be made (not over) $\frac{1}{50}$ inch larger in diameter than the pin, to allow for slipping same in.

Eye-bars and pins.

The practice of the latter company where eye-bars are of same thickness as the flat-bar, is to make the diameter of pin (if not governed by other circumstances) four-fifths of the width of bar (or $d = \frac{4}{5}.b$). In such a case the width of metal beyond the eye (at end of bar) is made equal to the width of bar (or $a = b$) and the width each side of eye equal to three-quarters of the width of bar (or $c = \frac{3}{4}.b$), see Figure 162. Where larger pins are used the proportion must be even more increased on account of the greater amount of weakening by welding.

The above sizes are good averages. In some cases the metal around the eye forms a concentric circle with the eye. In such cases (if not required to be larger) the radius of the eye is from three-eighths to one-half of the width of flat, and the radius of the surrounding circle is from four-fifths to nine-tenths (of the width of flat) *larger* than the radius of eye. The thickness of eye is, usually, but not necessarily, the same as that of the flat.

For further information as to sizes, etc., the reader should consult the hand-books issued by the different rolling-mills, taking care to get the latest issues, as they are constantly changing their rolls and stock sizes.

These books will also give the practice of each mill for locating holes in flanges of beams, channels, etc., sizes and weights of separators, manner of connecting beams by framing, etc.

Table XXXIV gives in condensed form the results of the most recently published tests on irons and steels.

POSTSCRIPT TO CHAPTER VIII.

Since writing the foregoing chapter a claim has been made by J. W. Bookwalter, an iron manufacturer of Springfield, Ohio, to have perfected a new process which will revolutionize the manufacture of iron and steel. He uses what he calls a Robert converter, which is the same in principle as the Bessemer, excepting that the air is blown in horizontally.

The claims made are: That he can produce any quality of iron or steel from the same furnace; that the impurities can be gathered and floated off on the surface; that the silicon can be controlled and burned out separately, ahead of, and without affecting the carbon, which can afterwards be reduced to any desired quantity, thus leaving the mass to be poured from the converter either pure wrought-iron, or steel of any grade, as may be desired; and that the control of the silicon and carbon is perfect.

Similar claims have been made before, but were never substantiated. Should, however, these claims prove to be genuine, it would at once mean a large saving in the cost of manufacture of all grades of iron and steel. It will be readily seen that not only is the cost of handling the iron several times and the cost of puddling (by hand) done away with (for if this invention does all that is claimed for it, the pig-iron could be melted and run directly to the final rolls), but the cost of furnaces, etc., will be greatly reduced, as one and the same converter will make any quality of iron or steel desired.

Then, too, it would solve the problem of strong, cheap castings, as these could now be made of a high grade of steel at about the cost at present of ordinary cast-iron; this, of course, would mean a casting with the forging, welding and other properties of wrought-iron.

It is also claimed that the blast need not be nearly so strong as in the Bessemer converter, and hence the cost of this new converter is not only very much less, but its tuyères and lining will outlive many times those of a Bessemer converter.

It is further claimed that not only is the reduction in cost of steel very great, but that the cost of rolled-iron is reduced to the same level as the cost of steel.

LOUIS DECOPPET BERG.

[To be continued.]

THE POOLING OF BIDDERS.

PURCHASERS of bridges have only themselves to thank for the institution of pooling. Were contractors assured of fair dealing in every case, they would prefer to send their bids by mail; but, unfortunately, partiality is too often the order of the day. Therefore, in self-defence, they have been forced to pool. The following amusing incident was related at the rooms of the Engineers' Club of Kansas City, after one of the meetings, at which the contents of the first edition of this pamphlet were discussed. It was published the next morning in the Kansas City *Journal*, and, as it exemplifies very clearly one of the numerous tricks of the trade, it is reproduced here, notwithstanding its rather inelegant diction:

"A bridge-builder was telling me a sort of funny story the other day, and, I have no doubt, similar occurrences often happen. He was down in Southern Missouri some time ago to bid on a bridge. Of course he was pooling, or he wouldn't have been there. There were fourteen bidders in the whole crowd, and thirteen of them were to put in bids away up out of sight, while the fourteenth would put in a bid that would be just low enough to be in sight, get the work, and pay the other thirteen a commission.

"Some one ascertained that the Union Bridge Company, of Buffalo, had submitted plans to the commissioners, but had no representative

on the ground, and, of course, the pool was 'busted' unless the Union Company could be floored.

"Now, county commissioners don't know a bridge-plan from a picture of Christ before Pilate. They look at them very soberly, and, if no one is around who has sense enough to see that they are holding them upside down, they are quite liable to get a reputation for wisdom.

"We had to 'down' the Union Company or lose our travelling expenses, and one of the bidders present said:

"'I'll go in and look at those Union plans, and see if I can find anything the matter with them.'

"He went in and expatiated on his own plans, told the county commissioners that all the rest of us were thieves, and then came out and said:

"'Boys, those plans are on the table in there, and I can't find a cussed thing the matter with them except that the lower chord of the bridge is made of round iron instead of flat.'

"Well, of course you know that makes hardly any difference at all about the strength or durability of a bridge. It's just a little unusual, that's all, and I suppose that the Union Company would have given flat iron at the same price.

"Then I went in, and after telling the commissioners how good I was, and how my plans were the greatest effort of my life, I looked around casually and glanced at the Union plans and said: 'Humph! That fellow's pretty old-fashioned. Uses round iron, don't he?'

"Then I went out and the next man went in, and after ten minutes' free exhibition of the noblest public spirit Missouri ever produced, his eye caught the Union bridge-plans, and he said: 'Well, that fellow is cutting in on his margin of safety, I — should — say. Uses round iron in his bridge, don't he?'

"Then the next man stepped up, and after the usual ten-minute course in civil engineering, furnished free to the commission on account of official position, he said, the instant that his roving sight happened to be riveted by the glaring defect in the Union plans:

"'Holy smoke!'

"'What's the matter?' asked the bridge commissioners.

"'Nothing at all, gentlemen; nothing at all.'

"'Anything wrong with those plans there?'

"'Gentlemen, if there was anything wrong you would have to find it out from somebody else besides me,' and he went out.

"After the commissioners had been subjected to ten more such experiences they threw out the Union plans, and there were thirteen commissions paid for one contract." — *Iron Age.*

ILLUSTRATIONS

[Contributors are requested to send with their drawings full and adequate descriptions of the buildings, including a statement of cost.]

AN OLD GERMAN STREET.

[Gelatine Print, issued only with the Imperial Edition.]

SHADES AND SHADOWS, PLATE III.

See article on this subject, elsewhere in this issue.

A STAIRCASE IN THE CATHEDRAL, BURGOS, SPAIN, (XV AND XVI CENTURY WORK).

RETABLE IN THE CATHEDRAL, BURGOS, SPAIN, (XV CENTURY WORK).

PLATERESQUE DOORWAY, BURGOS CATHEDRAL, (XV CENTURY WORK).

XVI CENTURY CARVING, BURGOS CATHEDRAL.

See article elsewhere in this issue.

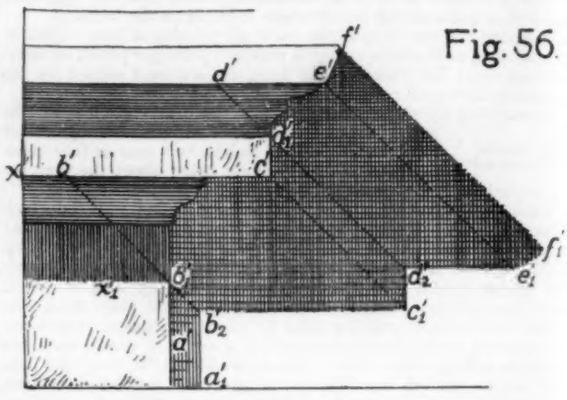
HOUSE OF H. F. WATSON, ESQ., ERIE, PA. MESSRS. GREEN & WICKS, ARCHITECTS.

A BLOCK OF HOUSES, NEW YORK, N. Y. MESSRS. CHARLES W. ROMEYN & CO., ARCHITECTS, NEW YORK, N. Y.

Cooking Food by Electricity. — The Hotel Bernina, at Samaden, has for some time been lighted with electricity, power being supplied by a waterfall. As, during the day, this power is not required for lighting, and is, therefore, running to waste, the proprietor of the hotel has hit upon the idea of utilizing the current for cooking when it is not required for lighting, and an experimental cooking apparatus has been constructed. This contains German silver resistance-coils, which are brought to a red heat by the current, and it has been found possible to perform all the ordinary cooking operations in a range fitted with a series of such coils. — *The Electrician.*

ARCHITECTURAL SHADES AND SHADOWS.[1] — VI.

CHAPTER VI. — PRACTICAL APPLICATIONS OF FOREGOING PRINCIPLES.



Summary of principles already laid down; application in practice of rules given in Chapters IV and V; points of interest in delineation of architectural shadows in general; analysis of processes and operations employed in casting shadows of a porch in plan and in elevation.

63. BEFORE proceeding to the practical application of the rules and principles laid down in preceding chapters, it may be well briefly to summarize them as follows:

a. By finding the shadows of any two points we can locate the shadow of the right line passing through them, in direction, and in length also when the points given are the extreme points of the line.

b. The shadows of a number of points in a curve determine the shadow of the curve with an approximation to accuracy depending upon the number of the points; and the shadows of tangents give also the direction of the curve of shadow at each point of tangency. This principle is applied to the case of the circle by means of the circumscribed octagon.

c. The shadows of rectilinear solids — prisms, parallelopipeds and pyramids — can be found without knowing their lines of shade, by what we have called the "reverse process." The shadows of the faces, edges, or angles of the solid being found, the extreme outline thus obtained is the line of shadow, or shadow of the line of shade, which we can then identify by tracing back the rays from the various parts of the outline of shadow to points upon the projections of the solid.

d. Shadows of pyramids and cones are determined by the shadows of their vertices and bases; and the shadows of cylinders by the shadows of both bases connected by parallel tangents.

e. It has also been observed that any coördinate plane of incidence may be taken as a plane of projection, so that the line which in plan represents a vertical plane may be taken as a new $G\,L$, in order to determine the distance to right or to left of any shadow cast upon that plane by a point or line; and that any line which in elevation represents a horizontal plane may similarly be used to determine the distance to right or left, of any shadow which it receives. We can thus easily find any shadow or set of shadows falling upon any horizontal surfaces, or upon any vertical surface parallel to $V'\,P$. Shadows falling upon irregular, curved, or oblique surfaces are reserved for later discussion.

64. These discussions have so far related only to shadows cast upon coördinate planes by points, lines (especially principal and diagonal lines), squares and "lozenges," with their diagonals; octagons and circles, pyramids, cones and cylinders. But these rules and discussions are in themselves sufficient to enable us to cast the shadows of nearly all architectural objects presenting plane surfaces of incidence parallel to $H\,P$ or $V'\,P$. This statement is exemplified by Plate III, in which Nos. 1 and 2 show a porch in front and side elevation, and in plan, with the shadows. The processes by which these shadows are cast will be given in detail in the latter part of this chapter; our purpose at present is to show how large a part of the problem is solved by means of the simple rules already laid down for the lines and figures enumerated in the opening lines of this paragraph.

65. 1. *Figures parallel to the plane of incidence*, casting shadows parallel to themselves, occur in the lower edges, respectively, of the corona of the main cornice; of abaci of imposts, and of all

[1] By A. D. F. Hamlin, Instructor in Architecture in the School of Mines, Columbia College. Continued from page 11, No. 706.

NOTE. — [In view of the inconvenience of having to refer to back-numbers for explanations of the notation used in these papers, the following memorandum will be found of service.]

$H\,P$ = horizontal plane of projection; $V'\,P$ = vertical plane of projection; $G\,L$ = ground-line or horizon. Capital letters designate points and lines in space, small italics their horizontal projections, and the same accented or "primed," their vertical projections. Subscript figures indicate points of shadow: small figures above the line indicate points of shade. Greek letters (α, β, γ, θ, δ,) designate angles. The *diagonal* of a line or dimension is its length multiplied by $\sqrt{2}$.

fillets and belt-courses generally on the front of the elevations of the porch. Their shadows fall mostly on the front wall of the porch, and are parallel to the edges that cast them. Those portions which do not fall upon the porch itself are cast upon the main wall of the building, and are, therefore, still parallel to the edges that cast them, as for example $a'_2 b'_1$ and $b'_1 c'_1$ cast by the right-hand end of the lower edge of the corona, and by its right-hand vertical corner. Other examples are the shadow of the archivolt (both of its extrados and of its intrados) upon the porch-front; of a small portion of the main arch upon the front of the main building; of the vertical corners of the porch and its piers, upon the same wall, and of the stair-parapet upon the risers of the steps. In the plan, where the piers are supposed cut off at a certain level above the landing, the top-surface of the left-hand pier casts its shadow parallel to itself on the landing, and the top right-hand corner of the stair-parapet casts shadows parallel to itself on the third and fourth treads of the steps below.

2. *Lines normal to the plane of projection* appear in the elevation in the upper edges of the cornice and of imposts and belt-courses returning back to the main wall, and in the edge of the stair-parapet returning back towards the landing. The shadow of the most important of these forms the upper line of the shadow cast by the porch on the main wall from which it projects, and there are several other shadows cast at 45°, very short but important, which form the upper limits of the shadows of the right-hand corners of imposts, fillets, belt-courses, mouldings, etc. In the plan, the shadows of the corners of the piers and that of the front edge of the stair-parapet, are in the same way cast at 45° across all the various surfaces of incidence on which they fall.

3. *The shadow of the square* is made use of to assist in finding that of the circle, and both of these are, therefore, employed in finding the shadows cast by the small side-arches of the porch upon the main wall of the building; and again, in drawing the shadows of the circles which appear in the design of the iron railings under those arches. The method briefly described in 57 for delineating geometrically the length and inclination of the axes of the circle's shadow, here comes into use when any considerable accuracy is desired. The circles in both these cases are in profile planes (52), and the side-elevation is needed as an auxiliary to determine their exact dimensions and position in front-elevation.

4. The diagonal-bars of the railings just mentioned are *diagonal lines in the profile pl ...e*, and their shadows are seen to agree with those given in Figure 43, C.[1]

66. The practical work of casting the shadows of even a simple architectural object like the porch shown in Plate III, involves difficulties of detail and of procedure to which it is worth while to call attention, as points of general interest. The most important of these relate to the lines of shade, which are the key to nearly every difficulty which the draughtsman encounters. *It is important to be able always to identify the portion of the line of shade, which corresponds to each part of the shadow, and vice versâ;* for since the whole line of shade must cast its shadow somewhere, the shadow of an object has not been completely drawn till every part of that line has been accounted for. Consequently when the shadow cast upon one plane belongs to only a part of the line of shade the remaining part of the shadow must fall upon some other surface. Sometimes this is a profile plane (such as the jamb of a door or window, or the side of some projecting mass or feature), in which case it is not visible either in plan or in elevation; but the great majority of architectural shadows fall upon vertical and horizontal planes, so that whatever part of the shadow is not visible in elevation must come into view in the plan, and *vice versâ*. Now the point where it passes from one plane to the other (as from one tread of a flight of stairs to the face of the next riser above or below) being a point of the intersection of the two planes, appears in both plan and elevation, so that by marking all such points and working backwards and forwards between plan and elevation, the shadow may be traced continuously from surface to surface, until the whole line of shade is accounted for.[2]

67. In the next place it should be observed that while the line of shade of any simple solid is always a continuous line, the line of shade of an architectural feature made up, like a capital or a cornice, of several simple solids combined, is often discontinuous or made up of the several distinct lines of shade of its various component parts. The extremities of these separate lines of shade are so connected together, however, by rays of light, that they cast a continuous shadow. Whenever the line of shadow of one part *A* falls across the line of shade of another part *B*, the intersection of these two lines is at once a point in the second line of shade, and the shadow of a point in the first by which the latter (the line of shade of *A*) is divided into two parts, one of which, as just observed, casts its shadow on *B* itself, while the shadow of the remainder falls on the main surface of incidence. The shadow of *B* upon the same surface joins on to this, and together they form the continuous shadow of the solid. *Thus the point of junction of these two shadows is the common shadow of a point in each line of shade*, the three points being connected together by a single ray. If then we pass a ray through the intersection of the shadow of *A* with the line of shade of *B*, the point where this ray meets the line of shade of *A* divides the part whose shadow falls on *B* from that which casts its shadow on the general plane of incidence. And the point where the other end of the same ray terminates in the continuous line of shadow of the solid separates the part which belongs to the line of shade of *A* from that which belongs to the line of shade of *B*. Thus in Figure 56, representing a Tuscan cornice, b' is at once a point of the line of shade $a' b'$ and the shadow of the point b' on the line of shade $b' c'$, which line is thus divided into two parts, that to the left of b' casting its shadow on the frieze, and that to the right on the main surface of incidence to form a part of the continuous shadow of the cornice. And both b'_1 and b' cast a common shadow at b'_2, which divides the shadow of $b' c'$ from that of $a' b'_1$, a *continuous shadow being thus cast by two distinct lines of shade connected by a ray of light.*

68. It is important to dwell on this ray of light and the point of intersection of the shadow with the line of shade, because many of the difficulties of shadow-casting disappear if, proceeding from such points of intersection, we at once determine what portions of each line of shade cast their shadows on one and what on another of several planes of incidence.

In the same way by observing the ray $b' b'_1 b'_2$ we see that the *distinct shadows cast upon different surfaces by a continuous line of shade, are linked together by rays of light*, as in Figure 56, the ray $b' b'_1 b'_2$ connects the separate shadows $c'_1 b'_2$ and $b'_1 x'_1$, cast by the continuous line of shade $c' b' x'$. And a careful study of the lines of shade in this figure, and of the shadows they severally cast, will explain how and why the shadow of a cornice differs in profile and dimensions from the profile of the cornice itself.

69. Thirdly, any limited surface of incidence may be supposed indefinitely extended, so as to receive the whole shadow of a given line of shade, all intervening objects being supposed removed, because it is often easier to draw the whole shadow of an object and then discard all but that portion found to lie within the limited surface of incidence, than to go through the somewhat tedious process of finding exactly

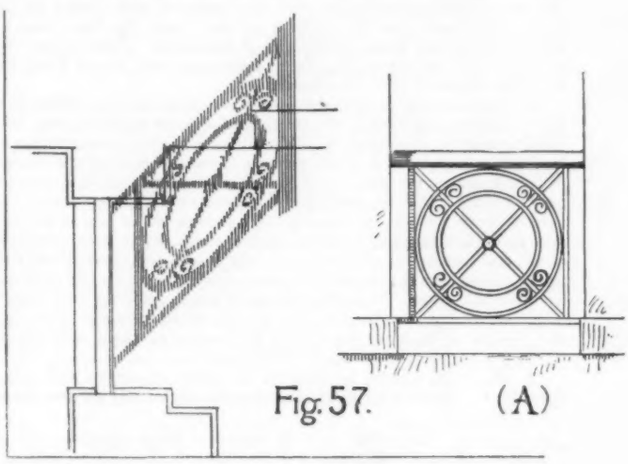


Fig. 57. (A)

what portion of the line of shade casts its shadow within those limits and then to draw that limited shadow. Thus in Figure 57 we have the plan of a panel of railing consisting of two circles, the larger one inscribed in a square (see the side elevation in A) and intersected by two diagonal bars. A part of its shadow falls on the main floor, and possibly another part on the doorstep. The whole shadow of square, circles, and diagonals is drawn according to the rules given in Chapter V, as if falling on the floor. In Figure 58 the same shadow is drawn as if cast on the plane of the doorstep, or sufficiently drawn out to show that no part of it would really be cast upon the step, the pier of the arched door intervening and evidently receiving what otherwise would fall on the plane of the doorstep. That portion of the shadow still unaccounted for obviously falls on the front or riser of the doorstep. Figure 59 shows the completed drawing, with the shadows of the piers falling across a part of the railing, and consequently swallowing up a corresponding slice of its shadow from *a* to *b*, or cast across the shadow only of the railing as at *c*, the pier in this case itself receiving that part of the shadow of the railing which otherwise would be seen at *c*. These figures resume, in duplicate, the operations performed in Plate III, No. 2,

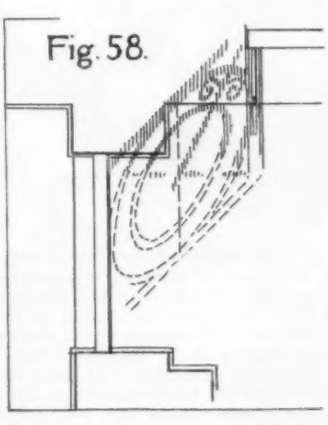


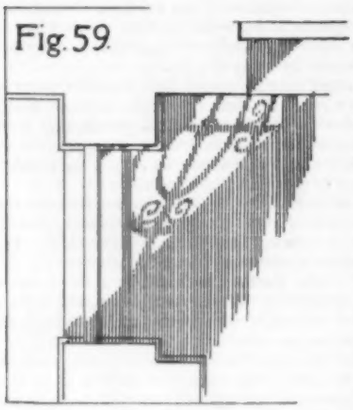
Fig. 58.

[1] See No. 706, for July 6, 1889.

[2] In Figures 37 and 38 (issue of May 11, No. 698), this operation may be traced both in elevation and in perspective.

where the railing and its shadow are easily recognized; while in the elevation, No. 1, we see on the front of the doorstep the part of the shadow next adjacent to that which appears in the plan — the dotted lines showing that portion of this shadow which in reality is hidden by the front pier of the porch.

70. This method of procedure is one of the most commonly employed devices for correctly drawing broken shadows, that is, shadows falling across several surfaces; and it is important to observe that *when the various surfaces of incidence are parallel planes, the shadow, having been once outlined for one of them, may be transferred to or traced successively upon each of the others*, or (if tracing-paper is used) so much only as falls upon each surface may be traced each time from the original outline, care being taken that the successive shadows shall form consecutive parts of that outline. Thus, in Figure 60, the shadow of a circle falls on three successive planes, all parallel to *V'P*; the ellipse of its shadow may be drawn as though falling on some assumed vertical plane. The nearest plane is seen to receive only $a'b'c'$; the next segment, beginning with the points a' and c', falls on the next plane from c'_1 to d', and from a'_1 to e', and the remainder on the third surface from d'_1 through f' on to e'_1. These three segments of the shadow of the circle, taken together, should form the complete ellipse, $a'b'c'd'f'e'$, shown at *A*.



71. The converse of this operation is also very useful. When it is not evident at sight where the shadow of a given right line may fall, the line may be prolonged in either direction until some portion of its shadow falls upon a given surface, from which it can be traced over and across the other surfaces it encounters, and that portion only retained which is comprised between rays drawn through the extremities of the given line. So the shadow of an arc of a circle may be easiest found by completing the circle, or, at least, the semicircle, and casting its shadow, from which one can then cut off and retain so much as is contained between the rays drawn from the extremities of the arc. Thus the shadow of a cusp, of a segmental arch or of the outline of a Gothic arch, may be easiest drawn by casting the shadow of each of the circles (by means of their centres) of which the various curves of the outline are arcs.

72. We have, finally, to consider the cases of arches and other openings.[1] These have equal and similar edges, one on the inner and one on the outer face of the wall, each of which in part belongs to the line of shade. Since it is not easy to determine by inspection just what portion of each of these edges is a line of shade, and, consequently, where its shadow begins and ends, the shadow of the whole of each line or edge is cast, and the innermost line of shadow is retained as the final outline of shadow of the openings. This is an application of the "reverse process" described in 62, and is the best way to treat all problems in which the line of shade is not easily ascertainable. Let us suppose a square window in a profile wall (Figure 61). Each of its edges, being a square, casts a parallelogram of shadow on the wall, as shown in the figure, and the two shadows (parallel to each other, and separated by a constant distance, equal to the thickness of the wall) intersect, leaving a smaller parallelogram of light, whose outline is the shadow of the window. Those parts of either edge of the window whose shadows appear as dotted lines, are either in shade themselves or cast their shadows on the jamb or sill of the window.

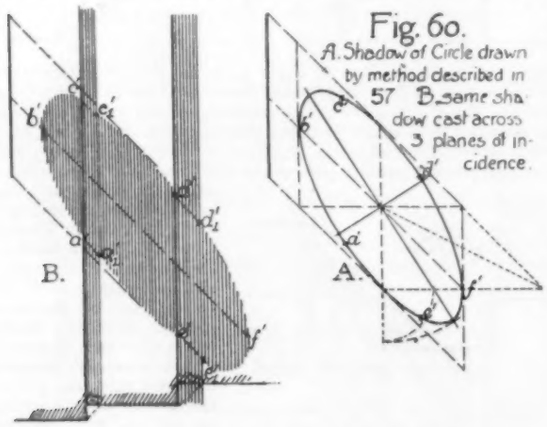
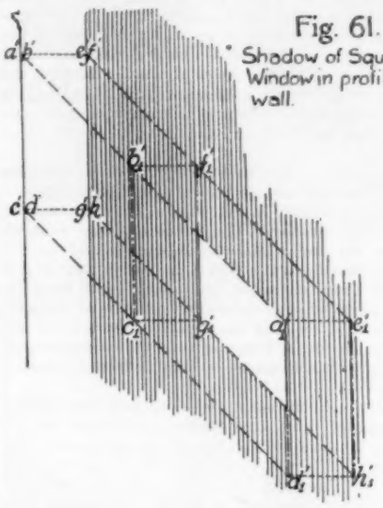
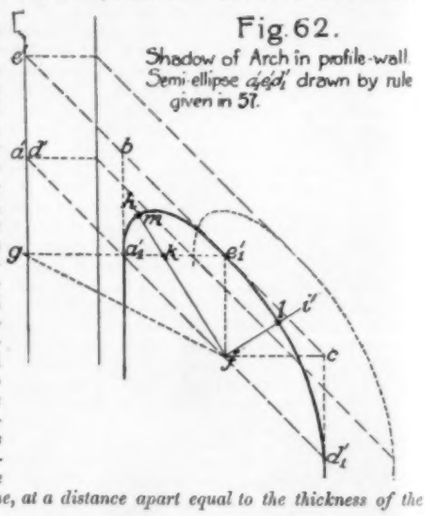


Plate III, No. 3, shows this principle applied to the square window, in section, in the profile-wall and to the gallery. The same principle is used in the case of the arched window in the same drawing, and this application of it is worthy of careful study.



73. The inner and outer outlines of an arch are equal and similar figures, and form the bases of a semi-cylinder having equal horizontal elements. The shadows of these two equal, similar, and parallel bases are equal and similar curves, whose corresponding points are connected by the shadows of the horizontal elements of the cylinder. When the wall containing the arch is parallel to the plane of projection, the shadows of the two edges of a semicircular arch are semicircles, with their corresponding points connected by lines which are the shadows of the horizontal elements of the arch-soffit. These elements, being normal to the plane of projection, and their length equal to the thickness of the wall, their shadows are cast at 45°, and are equal to the diagonal of the wall's thickness; so that *the constant distance apart of the shadows of the two semicircles, measured horizontally or vertically, is equal to the thickness of the wall;* measured directly between corresponding points, it is equal to the diagonal of that thickness. This is illustrated by the shadows of the arches in No. 4, Plate III. The two semicircles are usually drawn by first locating the shadows of their respective centres.

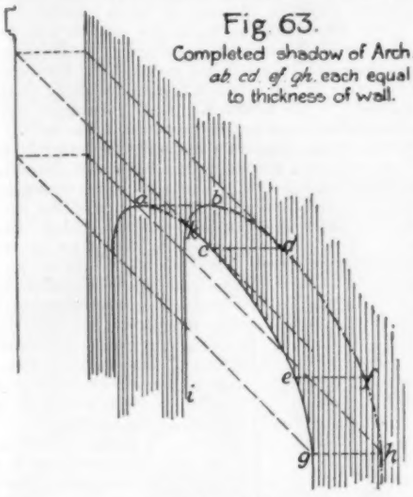


74. When the arch is in a wall at right angles with the plane of projection, the shadows of the two semicircles are ellipses, drawn by Rule (VIII); and the elements of the cylinder, or arch-soffit, being parallel to the plane of projection, cast shadows upon it equal and parallel to themselves. *Hence any pair of corresponding points of the two semi-ellipses are on the same horizontal line, at a distance apart equal to the thickness of the wall.*

In Figure 62 we have the vertical projection of a profile-wall containing a semicircular arch, whose radius and position are sufficiently indicated by the dotted lines which mark its impost and crown. No side elevation is, therefore, required in order to cast the shadow. Taking, first, the outside semicircle, and following Rule (VIII), we cast the shadow $a'b'c'd'$ of the half-square circumscribing it, and find the centre e'_1 of its long side. The half-ellipse of the shadow of the circle passes through a'_1, e'_1 and d'_1, tangent to the parallelogram at those points. If great accuracy is required, we employ the method given in 57. Laying off a horizontal line from a'_1 to the left equal to $a'_1 b$, we have at g one corner of the shadow of the half-square perpendicular to that circumscribed about the semicircle, and fg is its half-diagonal. Bisecting the angle $e'_1 fg$, we have in the line fh the direction of the semi-major axis, and in fi, at right angles to it, that of the semi-minor axis. The segment $e'_1 k$, cut off from $e'_1 g$ by this major axis, gives us the length of the semi-minor axis, which we lay off with the dividers, giving l as a new

[1] The "shadow" of an opening which admits light is not a misnomer, as it might at first appear to be. It is an outline of shadow which is surrounded by the shadow it limits, instead of inclosing it, and is truly cast by the line of shade of the window or opening.

point of the curve; and adding the same to $e'_1 f$ (which equals radius of the arch), we have the length of the semi-major axis, which we mark off at m, a fifth point of the curve, of which we now know five points and its direction at each, and the length and inclination of its axes. These operations may be performed upon tracing-paper, and the resulting curve alone transferred to the drawing, as in Figure 63.



Now the shadow of the other edge of the arch is precisely similar and equal to this one, so that if we have its centre or any point of it, we can trace the same curve in its new position; and as we have seen that the two curves are everywhere at a constant horizontal distance apart equal to the thickness of the wall,[1] it is an easy matter to trace the second curve from the first in its proper position, as shown in the figure, where ab, cd, ef, and gh are each seen to be equal to the thickness of the wall. The inside line $ikceg$ is the required line of shadow, the dotted lines being the theoretical shadows of those portions of the two edges of the arch which are in shade, or whose actual shadows fall across the soffit of the arch itself, as in Figure 64. Here only half the arch appears, it being in section. The lines of shadow of the whole arch are drawn and cut off at the shadow of the crown, the horizontal element at this point, with one edge of the wall in section, becoming a line of shade. The shadow of part of the outer edge from d' to b' falls across the soffit of the arch, and that of the next consecutive portion, $d'e'$, is cast upon the main plane of incidence to form part of the final outline of shadow.

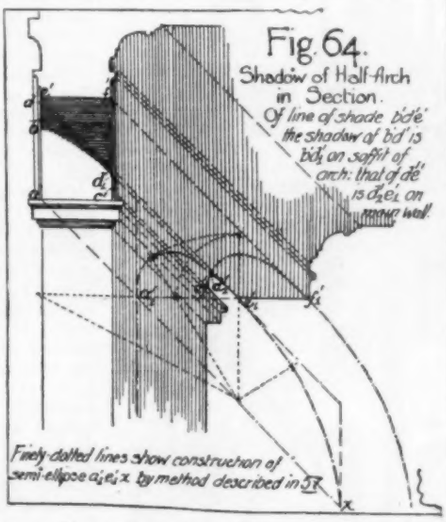


Fig. 64.
Shadow of Half-Arch in Section.
Of line of shade b'c'd' the shadow of b'c' is b'c'₁ on soffit of arch: that of d'e' is d'₂e'₁ on inner wall
Finely dotted lines show construction of semi-ellipse a'₁e'₁x by method described in 57

In all cases, the *position* of the shadow of the arch may be determined by casting the shadow either of its centres or of one of its piers, for which purpose either the plan or the side-elevation must be consulted whenever its distance from the plane of incidence cannot be assumed arbitrarily. In the porch shown in Plate III the shadows of the two side-arches are found in this manner.

(To be continued.)

LIGHT LOST IN WINDOWS. — The loss of light in passing through glass has been tested by two physicists of Berlin. A simple translucent but not transparent glass diminished the light 27 per cent; cathedral-glass, both white and with a slight ground-tint, 12 2-3 per cent; plain white Rhenish "double glass," 10 per cent; and plain thin mirror glass, 10 per cent. Ground glass with cut stars and a white glass background, such as is found in house fanlights, obstructed 60 per cent of the light; and plain ground glass with the background, 40 per cent. — *Worcester Gazette.*

[1] There is no term in mathematics for the relation of two similar and equal curves whose homologous points are all each from each equidistant. On the other hand, the terms *parallel* and *concentric* are applied interchangeably to curves having common centres of curvature. Were it not that usage has so thoroughly established this use of the two words, it would be far more correct to call two curves *parallel* when their distance apart, measured always in the same direction, is constant; so that the two words would mean entirely distinct things, and both relations would have mathematical names.

BITS OF BURGOS CATHEDRAL.

"WHEN a traveller returneth home, let him not leave the countrie where he hath travelled altogether behind him, but maintain a correspondence by letters with those of his acquaintance which are of most worth," saith the great philosopher.

And there were at least three in Spain with whom I would fain maintain correspondence. One of these was the *capellan* of a little chapel in Cadiz; another a noble priest who had devoted his spare time to photography and who placed at my disposal his dark-room and his learning, Don Juan Navaja; while the third was my one-time landlady, Doña Dolores, *Viuda de* Garcia, of Madrid.

Don Juan lived in Seville, but he could not have been the original of Byron's hero, either by birth or inclination, for he was pure-minded and honest, with a rugged sincerity that won you and held you.

As for Doña Dolores, the widow of the late lamented Garcia, it was not my admiration for her domestic qualities, though they were great, nor for her majestic presence, though it was that of the ideal matron of Rome; but her speech, that captivated me. Much may be learned from widows, as we all know — or ought to know — but it is not my intention to tell what I know about widows, only to mention that this particular one spoke the Castilian in all its purity. And this brings me around to Burgos, for in Burgos she had learned to turn those sonorous periods.

"You must go to Burgos, Don Federico, and there learn the Spanish; not the bastard speech of Andalusia, with its many Moorish words, but the pure Castilian of the Cid and Saint Ferdinand." I took the widow's advice (which was disinterested, as she was my landlady) and went forthwith to Burgos. Doña Dolores had not mentioned other attractions in Burgos, but I knew they were there, having dutifully studied my guide-book, and when the two open-work spires stood up against the leaden morning sky I knew they pertained to one of the grandest Gothics in Castile. Resolved that the city's treasures should not be sprung upon me unprepared, I repaired first to a hotel, as it was then five o'clock in the morning, and was shown to a room by a buxom damsel. After a three-hours' rest, and cup of coffee, I went out to make the treasures of Burgos my own. The city is, to-day, the city of the Cid, whose bones are preserved, in a fragmentary condition, in the city-hall; and of Saint

Ferdinand, who flourished some six hundred and fifty years ago; and of Fernan Gonzalez, a great hero, born exactly one thousand years ago; and of Diego Porcallo, Count of Lara, ancestor of the Cid; and of the beautiful Princess Sancha, whom Count Fernan brought

home, so triumphantly, as his bride. You feel that it is still the city of these ancient worthies, because so many memorials of them abound on every side, not only in the shape of statues, erected by grateful Burgalese, centuries ago, and in fountains; but the great city gate, the archway of Santa Maria. It is certainly a relic of the Middle Ages, with its battlements and flanking mural bastions. The oldest relic of ancient Burgos is to be found in the city-hall, — in the room containing the bones of the Cid, — that famous Roman or Gothic chair, used as a seat-of-justice over a thousand years ago. As you go down the street towards the market-place, about the fountain of which the beggars cluster like flies, you see the noble *casa del cordon*, with its *cordon* over the great doorway and rude stone statues on its walls. This was a house of one of those valorous Counts of Castile who made Burgos celebrated as the dwelling-place of real Gothic heroes. There was never a warrior, of course, like the Cid, *El Cid Campeador*, who was born here in the year 1026, and the site of whose house is still shown, indicated by rude monuments. It is a question whether Burgos is prouder of the Cid than of her great cathedral; but there is no question whatever as to which has to-day the nobler presence.

The cathedral, certainly, may not outlive the Cid; but it is a concrete fact, while the hero is, even now, being looked upon by some as a myth. Ferdinand the Saint is said to have laid the foundation-stone of Burgos Cathedral, in the year 1221. It probably surpassed the expectations of its founders, and out-grew the original plan, else why should they have set it on a side-hill and why should their successors have allowed surrounding buildings to obscure its grand proportions by their contiguity? To secure a photograph of the cathedral-spires I had to climb to the garret-window of a tall house opposite, even though I had a wide-angle lens, — one of Darlot's latest. Nothing can detract from the exquisite beauty of its twin towers, three hundred feet in height, with lace-work structure so open that the stars may sometimes be seen through them, at night. The principal façade of the cathedral looks west, with three portals and two high towers, a most ravishing rose-window, and a turreted balustrade-corridor.

Burgos Cathedral. From "*Encyclopédie de l' Architecture et de la Construction.*"

The structure of the cathedral is three hundred feet in length by two hundred in breadth, contains two hundred windows, seven stairways, nine fonts, nine choirs and lecterns, sixty tombs, ten confessionals, forty-four altars, one-hundred and forty paintings, and nine organs. Of statues and statue-groups there are more than one has time to examine, both outside and in, the lateral towers alone being encircled by no less than seventy.

Burgos Cathedral, in its design and general features, is purely Gothic, with central nave and side-aisles, transept, dome, lantern, choir and apsis, but with its outlines somewhat confused by the contiguous chapels, cloisters, and the Archbishop's palace. Of its purity, Street remarks, in his "*Gothic Architecture of Spain*," "There is little, if anything, to show that we are not in France, and looking at some of its best and purest thirteenth-century Gothic. There is no trace of Moorish or other foreign influence, the whole work being pure, simple, and good." He adds, on the Spanish cathedrals of note: "Just as Cologne Cathedral is an exotic in Germany, so are those of Burgos, Leon, and Toledo in Spain; so that, whilst Spaniards may fairly be proud of the glory of possessing such magnificent works of art, their pride ought to be confined to that of ownership, and should not extend to any claim of authorship.

"The demands of those three great churches upon our admiration are very different. The palm must be awarded to Toledo, which equals, if it does not surpass, all other churches in Christendom, in the beauty and scale of its plan — one of the most impressive churches I have seen. . . . But if Burgos Cathedral is far inferior in scale to that of Toledo, and somewhat so to that of Leon in skilfulness of design, it is in all other respects equally worthy of study, and in its general effects it presents far more Spanish than either of them." We know that between the twelfth and the fifteenth centuries the Gothic became the standard of ecclesiastical architecture, passing through its transitional period in the thirteenth century, attaining its acme in the fourteenth, and becoming Flamboyant, or "Orientalized," in the fifteenth. And in Burgos Cathedral we find an epitome of all these periods in which it was built.

Let us now enter this grand cathedral; but before we enter let us notice the internal arrangement, prevailing in all Spanish churches.

"The *coro*, or choir, is transferred to the nave, of which it occupies commonly the eastern half, the portion outside and west of the nave being called the *trascoro*, and to the east, between the choirs. Beneath the dome, the lantern or *cimborio*, is the *crucero*, or crossing, which with the transept is usually occupied by the people, the worshippers. A passage sometimes leads from *coro* to altar-screen, with brass or iron rails, to keep people from pressing the clergy.

"In the centre of the *coro* are usually two or three lecterns, for the great illuminated office-books. High metal screens are placed across the nave, — to the east of the *coro* and across its entrance, and these screens are called *rejas*. Behind the altar is a great sculptured altar-screen, or reredos, called a *retablo*."

The church furniture, also, is of the usual sort, though not so magnificent as it was before the French invasion, some eighty years ago.

Of the entrances, it seems those of the transepts are richest in sculpture; that of the transept-doorway known as the Puerta del Sarmental, being (the sacristan assured me) of the thirteenth century. It is profusely adorned with statuary. In the tympanum is a seated figure of our Saviour surrounded by emblematic images, and the archivolt thickly covered with seraphs and cherubim, some forty-five in number. Statues of Moses and Aaron, Peter and Paul, flank either side the doorway. But the side-entrance, opposite to the transept, known as the Puerta de la Pellegeria, is worthier of description, since it presents, perhaps, one of the finest *plateresque* studies in Spain. This *plateresque*, as we know, was a revival of the Cinquecento of Italy, called, in Spain, *estilo plateresco*, or style of the silversmiths, from the exquisitely-chiselled sculpture. On either side of this doorway are statues of the saints, and, in two square compartments above, the martyrdom of saints, John the Evangelist and the Baptist; above, again, the Virgin and child, a life-size bishop one side and angels the other. The Puerta Alba gives entrance at the opposite end of the transept, and, as it is about thirty feet above the pavement, a sixteenth-century staircase in the Gothic Renaissance leads to it. It adorns well the wall against which it is affixed, but does not strike one as in unity with the structural design of the building. The balustrade is of that exquisitely-wrought ironwork we find in the *rejas*, and all of the sixteenth century. Each of the fifteen chapels is adorned with an enormous *reja*, or high gate of ornamental ironwork.

I rambled through the cathedral under guidance of the sacristan, a young man of noble mien, who took an intelligent interest in the stranger at his side, and was delighted to point out the hidden beauties of the place, such as the obscurer carvings and earlier tombs. He led me to the choir, seated me in a favorable light, and

then called my attention to the carvings of the *silleria*, or choir-stalls, profusely ornamented, and over one hundred in number.

These carvings call to mind those in the Toledo Cathedral, but are not their equal. The carvings of foliage in the early work (of Burgos), says an authority, is good and very plentiful. The figured sculpture is still richer, and, whether in the thirteenth-century transept-doors, the fourteenth-century cloisters, or the fifteenth-century *retablos*, is amazingly good and spirited.

And he adds: "In sculpture, Spain is not so rich as France, but, on the whole, probably more so than England. Perhaps the triple

western doors at Santiago Compostello (date, 1188) are among the first works of their age."

These doors, by the way, may be seen, reproduced, at the Kensington Museum.

The high-altar, opposite the *coro*, contains some richly-sculptured forms, but is not notably distinct from a score of others in Spain, and we turn to the surrounding chapels. These number fifteen, and are mainly the gifts of noble families. By far the richest and most important is the Capilla del Condestabile, the chapel of the constable, Don Fernandez de Velasco, once viceroy of the great King Ferdinand, who was conspicuous at the siege and conquest of Granada, and whose *escudos*, or arms, are wrought upon the walls, guarded by skin-clothed savages.

These sculptures are highly wrought and fascinating, though grotesque, and are of the fifteenth century. Conspicuously beautiful,

are the effigies of the Count and Countess, who expired at about the time America was discovered, or in 1492 and 1500, respectively. A private chapel, still belonging to the descendants of the constable, is under the exclusive control of a special sacristan, who only gives you admittance for silver. He alone possesses the key that turns the lock in the great *reja*, and no one else can show you the treasures of the inner chapel, where are still preserved the ivory altar carried by the Count to the wars, some jewels, and a "Magdalen" attributed to Leonardo da Vinci. The altar-piece is dedicated to San Geronimo, and the noble Jeremiah is represented as in the desert, extremely haggard and emaciate, while his companion, the lion, shows unmistakable signs of weariness.

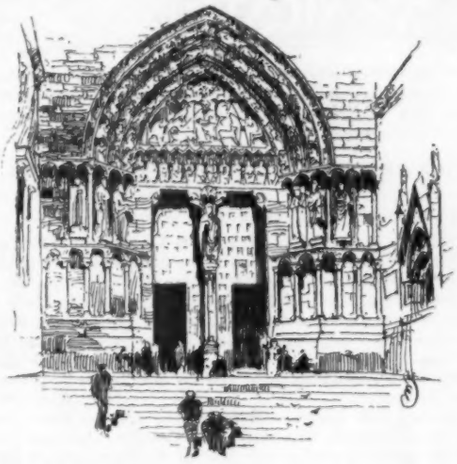
Other chapels are not less interesting, though less famous. One, the Chapel of the Presentation, contains an alleged Michael-Angelo, a picture of the Virgin; and another holds a horrible effigy of Christ, said to be covered with human skin, and which is credited with miracles innumerable.

Tombs there are, of all ages and in every style of carving, from the archaic sculpture of Bishop Maurice, beneath the choir-lectern (the founder of the cathedral, and who died here, 1240), to that of the latest bishop. But most of them are at least four hundred years old, and the year 1492 is a recent date.

From the gloom of the cathedral we turned to the sky-lighted cloisters, so rich in lancet and trefoil, and, at that time, hung with extraordinary tapestries of the fifteenth and sixteenth centuries. Fresh of color, tenacious of texture, these *tapices* seemed to have been not long ago woven and presented to the church. Chapels, again, are here, opening out of the cloisters, and one of them still holds that treasure unique, affixed against its northern wall, the veritable trunk of the Cid. Imagine a trunk (*cofre*) eight hundred years old, and try to imagine the joy of an American baggage-smasher with such a trunk at his mercy!

Thus am I diverted from things ecclesiastical to things secular. The sacristan tells me this is the last relic he has to show; yet I have not described, I fear, one-tenth the treasures these noble walls enclose, and I am appalled at my own presumption in attempting the task at all.

The most that we can do — or, at least, that I can do — is to indicate the site of the treasure, that others may follow in my footsteps and unearth it. I have followed in the footsteps of a master, and him again I quote: "Spain was the only country in Europe, probably, in which, at the same time, during the whole period from A. D. 1200 to 1500, various schools of architecture existed, much as they



do in England at the present day. There were the genuine Spanish-Gothic churches (derived, of course, from Roman and Romanesque); the Northern Gothic, executed by architects imported from France, and, in later days, Germany; and the Moresque buildings by Moorish architects for their Christian masters."

Two miles distant from the cathedral, walking along the banks of the river Arlanzon, beneath the shade of innumerable trees, I find the convent of Miraflores, or the *Cartuja*, as these Carthusians are generally called in Spain. Its altar-piece is said to be gilded with the first gold brought by Columbus from America, for it was erected by Isabella the Catholic at the time those great discoveries were being made. Here are tombs, declared to be the finest in Spain, perhaps in all Europe, in their carvings: alabaster and marble cunningly wrought by the silversmith's chisel into forms of beauty unsurpassed. A kneeling figure of the infant Don Juan is surrounded by lace-like carving of flowers and foliage intertwined. The *silleria*, the choir-stalls, are only surpassed by the towering Bishop's Chair, rich examples of what the masters of the world in those days wrought from wood.

Three miles away, at the opposite side of the valley, another convent, Las Huelgas, points a stone spire skyward. A more beautiful rose-window than that of Las Huelgas is not found, they say, in Spain. This convent was founded and sustained by ladies of noble birth, and only those of gentle breeding could enter here. To-day, even, the faces that peer through the gratings are those of noble nuns, and Castilian youths swear yet by the Gothic virgins of Las Huelgas.

Few monks are left within Cartuja's walls. A single *frate* guided me about, silent and wan. From his girdled waist hung clanking keys, but no other sound than theirs awoke the stillness within the cloistered walls; no brother greeted him or me. I went outside and sat beneath the cross. It was then the sunset hour, and over the hills came flocks of sheep, their tinkling bells sweetly breaking the silence of the place. They were received within the gate, the shepherd leaned his staff against a stone and disappeared. A golden cloud spread itself over valley and plain beyond, gilding tower and spire and ancient castle-wall, and night came peacefully then upon royal Burgos.

FREDERICK A. OBER.

SOCIETIES

PREAMBLES AND RESOLUTION PASSED BY THE NEW YORK CHAPTER OF THE AMERICAN INSTITUTE OF ARCHITECTS.

Whereas, It has been proposed to encumber with additional buildings the contracted limits of the City-hall Park, already too small a breathing space for the concentrated population which lives in its vicinity; and

Whereas, It would seem to be inconsistent for the city of New York to be appropriating land for building purposes which our forefathers intended for a park, while it is acquiring land in less populated districts for park purposes; and

Whereas, A large portion of the City-hall Park has already been taken for the Post-office, and a proposition has been officially made[1] to establish the New York Custom-house in the Battery Park; thus, with other instances, actually and prospectively accumulating very unfortunate precedents; therefore

Resolved, That we, as individual citizens, and in our corporate capacity as architects of the New York Chapter of the A. I. A., deprecate such encroachments on the rights of the people for whom the park was made; and think that the city of New York is able to and should acquire other property for its buildings.

A true copy, A. J. Bloor, *Secretary.*

COMMUNICATIONS

[*The editors cannot pay attention to demands of correspondents who forget to give their names and addresses as guaranty of good faith; nor do they hold themselves responsible for opinions expressed by their correspondents.*]

SECRET WRITING WITH TYPEWRITERS.

Portland, Me., September 19, 1889.

To the Editors of the American Architect:

Dear Sirs,—In your issue of June 8, I notice an article credited to the *Paper World*, "Secret Writing by Means of Typewriters."

"The device requires two typewriters similarly adjusted. They are so constructed that the type can be shifted from their normal position, so that the operator striking the keys in the usual way really writes other letters than those in his copy, forming a cipher copy. The receiver adjusts his machine in an opposite direction, and writes from the cipher copy, and his machine records the letters of the original copy."

To simplify this matter and make the scheme more generally useful, I would suggest that instead of changing the type (and thus making the machine useless for general correspondence) that each operator have discs of paper printed for each key; then by mutual understanding these discs may be placed on any key, and one machine would unravel what the other had written.

Instead of these paper discs, metal or pasteboard cups, with the characters stamped or printed on the bottom, may be reversed over each key, and if made to fit closely, will stay on all right; while they may at any time be removed, so that the machine can be used for general correspondence. Yours respectfully, King.

AN ANALYSIS OF AN EFFLORESCENCE.

Boston, Mass., September 18, 1889.

To the Editors of the American Architect:

Dear Sirs,—This efflorescence was received from Biddeford, Me., and is a case not at all infrequent along our coast, or wherever brick made along the coast are used. Thinking it might be of interest to your readers, I forward you the report to publish if it be your pleasure. Yours truly, Samuel Cabot.

——, Esq.
Biddeford, Me.

Dear Sir,—Thank you for the sample of efflorescence sent me on the 16th inst., which we have already examined.

It proves to be chiefly carbonate of soda, with a little lime and magnesia, and a little of sulphate of soda.

Without knowing the facts I should yet feel almost certain that the bricks from which this efflorescence was taken were made from salt clay, the salt yielding the acid in the burning process, during which process it becomes converted into silicate of soda, which slowly dissolves under the action of the weather, and becomes converted into carbonate of soda when exposed to the atmosphere. Yours truly,

Samuel Cabot.

TRADE SURVEYS.

In the mass of contradictory statements made in the daily and commercial and financial journals of the country, it is next to impossible to draw inferences that will bear the test of critical examination concerning trade and business commissions. Either the reports furnished the public press are one-sided and incorrect, or they are, to all intents and purposes, false. It is the earnest desire of parties controlling large operations, whether in railroad operations or in financial journals, to create the most favorable impression upon the stock-buying public. It is the desire of the manipulators of stocks to stimulate buying not only among buyers on this side of the water, but upon the other, and to that end a great deal of information, so-called, and of statistical matter has appeared from day to day and week to week in reputable journals, daily and weekly. At no time for years has it been as incumbent upon investors, especially in large blocks of capital, to carefully investigate and weigh all the surroundings. This statement is not made in view of any actual or even threatened danger to investors, but because of the enormous influx of capital from abroad, which is changing conditions on this side. A great deal of American capital is being rapidly liberated, and will naturally seek new channels of investment. Although the danger is not apparent, or even suspected, by the average financial and economic writer, the fact is, nevertheless, true that this influx on one side and liberation on the other threatens to bring about at some early day a speculative tendency, and, perhaps, an actual speculative era, not only in real estate, but in stocks and in industrial properties. The only object in commenting upon this tendency is to direct attention to the undercurrent, which, like many undercurrents, may remain there, and never appear on the surface to disarrange surface calculations. The immediate and remote effects of this influx of capital will probably be to enable American enterprise to accomplish what it could not otherwise accomplish for years to come. It is a most fortunate occurrence at present, and from very excellent authority it is learned that this financial crusade has only set in. There are a dozen or more negotiations now pending in Eastern cities having reference to the purchase of valuable American properties, some of them involving the purchase of railroad properties; but foreigners are a little apprehensive of the sharp practices of our American railway kings, lest their purchases might be rendered practically worthless by over-reaching financial management of stocks. The fact of the matter is, at least in the opinion of some very eminent economical authorities of this country, that the present influx of capital and the promised influx is averting, and will continue to avert, what they term the possible and even threatening financial stringency. There are not a few very able financiers in this country who regard the extraordinary development of our industries and business with alarm, because of the absence of any permanent and sufficiently elastic financial system. These fears may have very little foundation, but they, nevertheless, exist. They seldom find expression in public print, but in private banking circles the possibility of danger is often discussed. In the business world there is nothing whatever to discourage. It would be difficult to point out an industry in which an expansion of capacity is not in progress. It would be as difficult to find an industry in which there was any accumulation of productions. Distribution was never more uniform and satisfactory. There is not the least symptom of speculation or of overproduction, or of a weakening of credit or of a decline in confidence.

The industries of New England are exceptionally prosperous. In some quarters there is a complaint of lack of labor. In Maine the complaint was recently made that several hundred looms were idle for lack of the usual supply of Canadian labor. In Connecticut and Rhode Island there is no surplus labor, and the various manufacturing interests of this State were never more profitably engaged. There have been times when industrial stocks paid higher dividends, but there never was a time when as much satisfaction existed as to the permanency of good returns. In New York City and State a heavy business is being transacted, and building operations are still almost at their maximum point. The same is true with reference to building operations in the cities farther West. Architects in Philadelphia report a wonderful activity for the autumn season. Similar reports have been received from architects in Chicago, St. Louis and in some of the smaller cities of the far Northwest. The supply of lumber in all markets is very large, and prices are rather sagging notwithstanding the claims of some of the larger manufacturers that a hardening process is at work. So many new sources of lumber-supply have been developed, and so many hundred new saw-mills have been erected that it is unreasonable to expect any higher range of prices. The supply of Southern lumber in Northern markets is very large, and Northern manufacturers are giving vitality to the movement to invest in Southern lumber properties. Extensive purchases of timberland are being made, and during the past two months some of the finest belts of timber have been purchased by Northern capitalists. In most of these purchases the object is not to realize immediately, but to secure valuable timber for future contingencies. The upward tendency in Michigan and Wisconsin pine seems to have been arrested, but that tendency will be controlled very largely by the progress of building in the far Western and Northwestern States, which look to those two places for lumber-supplies. Turning for a moment to the iron trade, it is found to be in excellent shape. Within six days steel-rails have still farther advanced. This is due, first, to the increasing demand for rails, and to the increasing cost of slab-steel and billets. The prospects in the iron trade have not been better for years, and the winter will be a very busy one for both crude and finished iron and steel. Ship-building and car-building, as well as bridge-building, will absorb much more than the usual winter-supply. It now transpires that a larger amount of railroad-building will be done next year than was done this. It is also evident that the extraordinary demand for all kinds of machinery and mechanical appliances will continue without abatement during the winter. There is also an assurance that the demand for wood-working machinery will be exceptionally active this winter. In other industries there is no evidence of weakening. The textile-goods manufacturers are, for the most part, crowded with work. Congress will be called upon to make some tariff-adjustments this winter in the interest of New England manufacturers. The coal trade is very active throughout the West, but the anthracite region of Pennsylvania is working under a restriction. The manufacturers of supplies for house-furnishing nearly all report a busy year, and factories are now crowded with work for winter-delivery. Manufacturers of wall-paper, gas-fixtures, carpetings and interior decorations have had an extremely busy season since July 1. The shipments of machinery for shop and mill purposes to the Southern cities since that date have been in excess of the shipments of any former-like period. The Southern farmers are successfully combining for mutual protective purposes, and the surplus wealth for outside expenditure from the fourteen Southern States will, according to a rough guess, run from 25 per cent to 30 per cent over last year. Producers in all avenues of activity are aiming at a partial and moderate restriction. In former years the only controlling idea was to make the most possible, and crowd productions upon the market regardless of commercial consequences. That wild management has disappeared, and merchants and manufacturers are now taking a broader and more business-like view, with beneficial results to the country at large.

[1] Several years since by the Supervising Architect of the United States Treasury Department.

S. J. Parkhill & Co., Printers, Boston.

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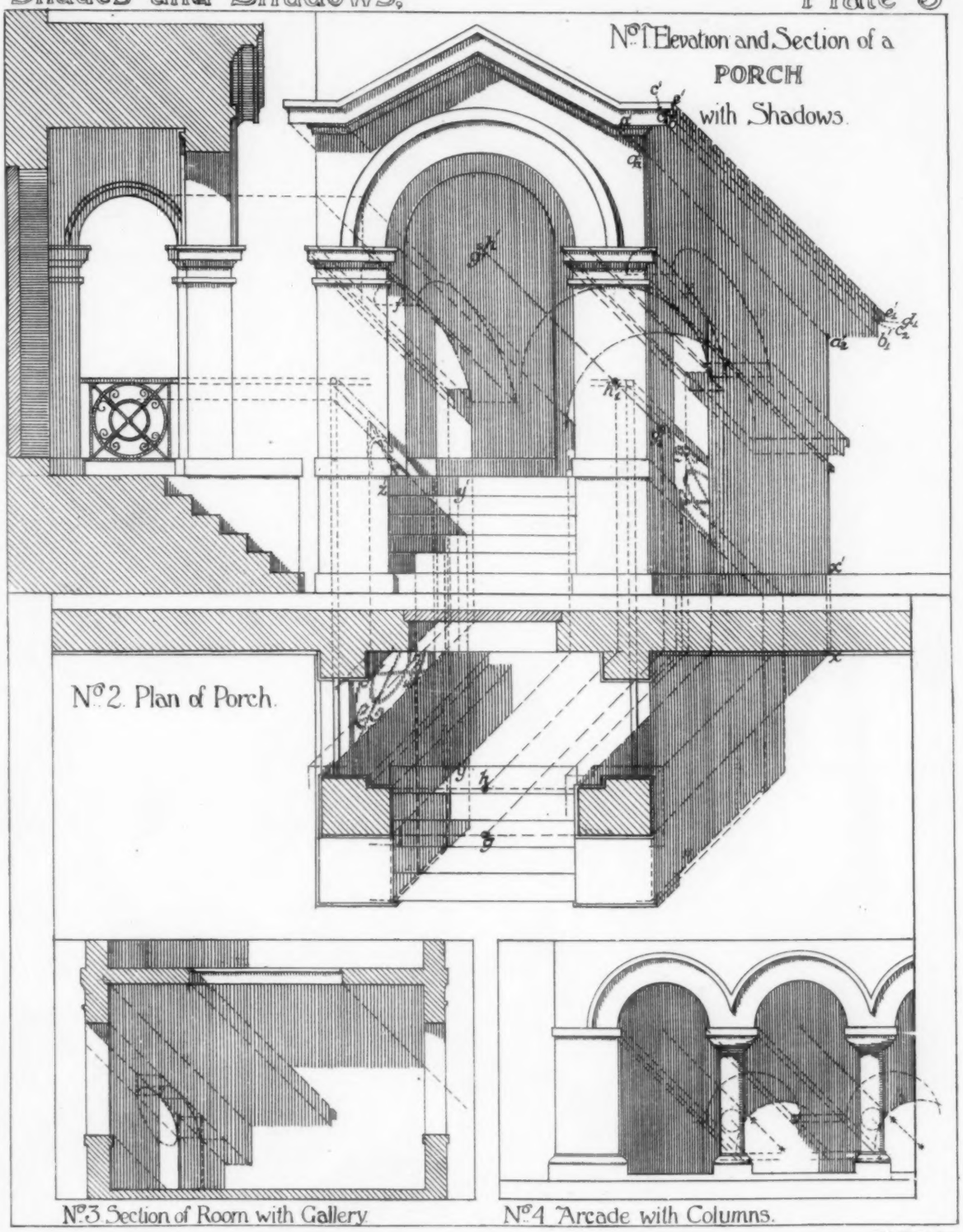
Shades and Shadows. Plate 3


No. 1 Elevation and Section of a PORCH with Shadows.
No. 2. Plan of Porch.
No. 3 Section of Room with Gallery
No. 4 Arcade with Columns.

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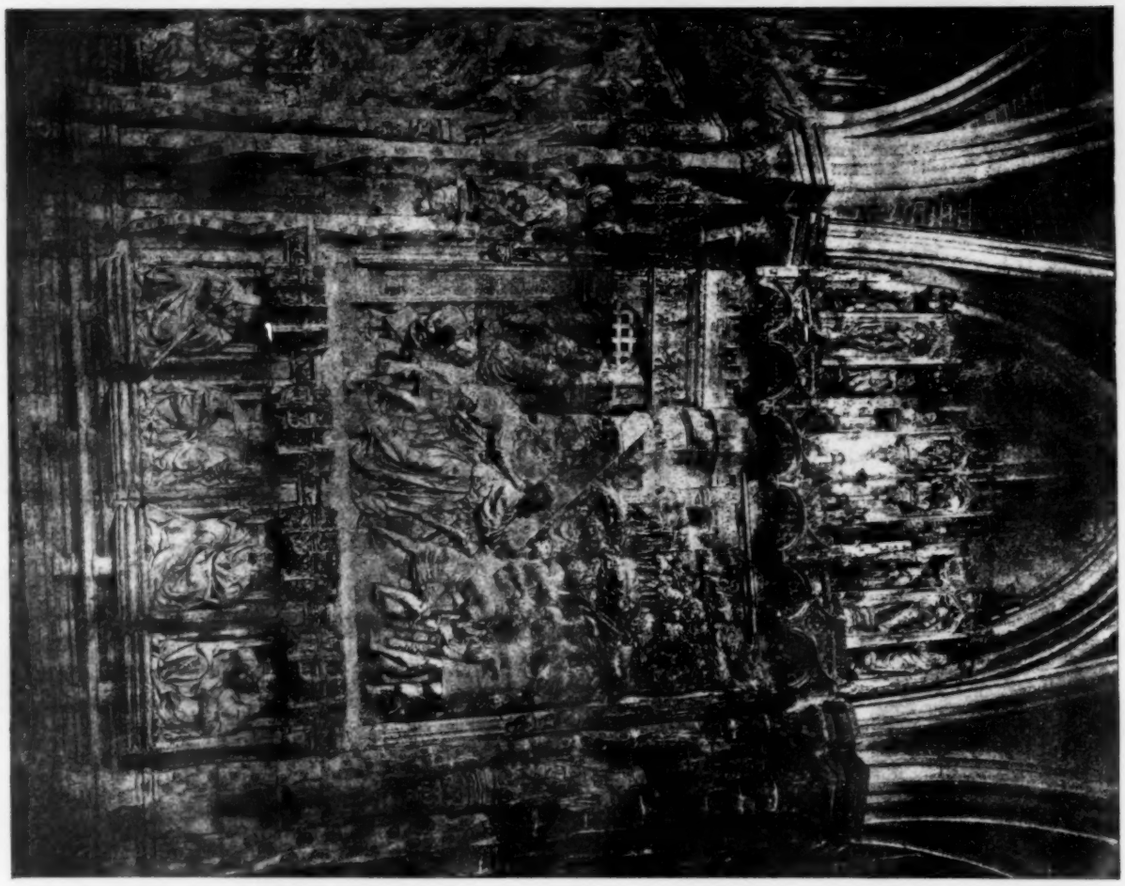
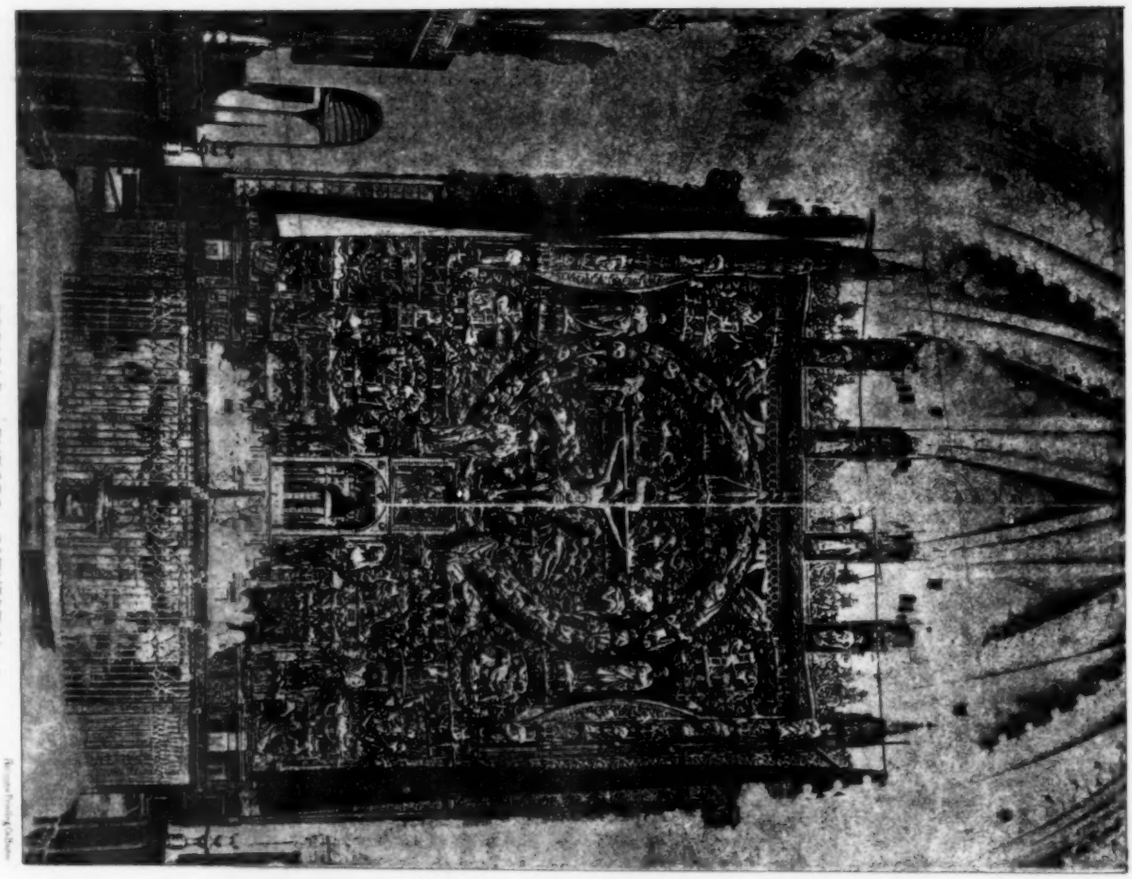


XVI CENTURY CARVING · BURGOS CATHEDRAL ·



· RETABLE · BURGOS CATHEDRAL ·

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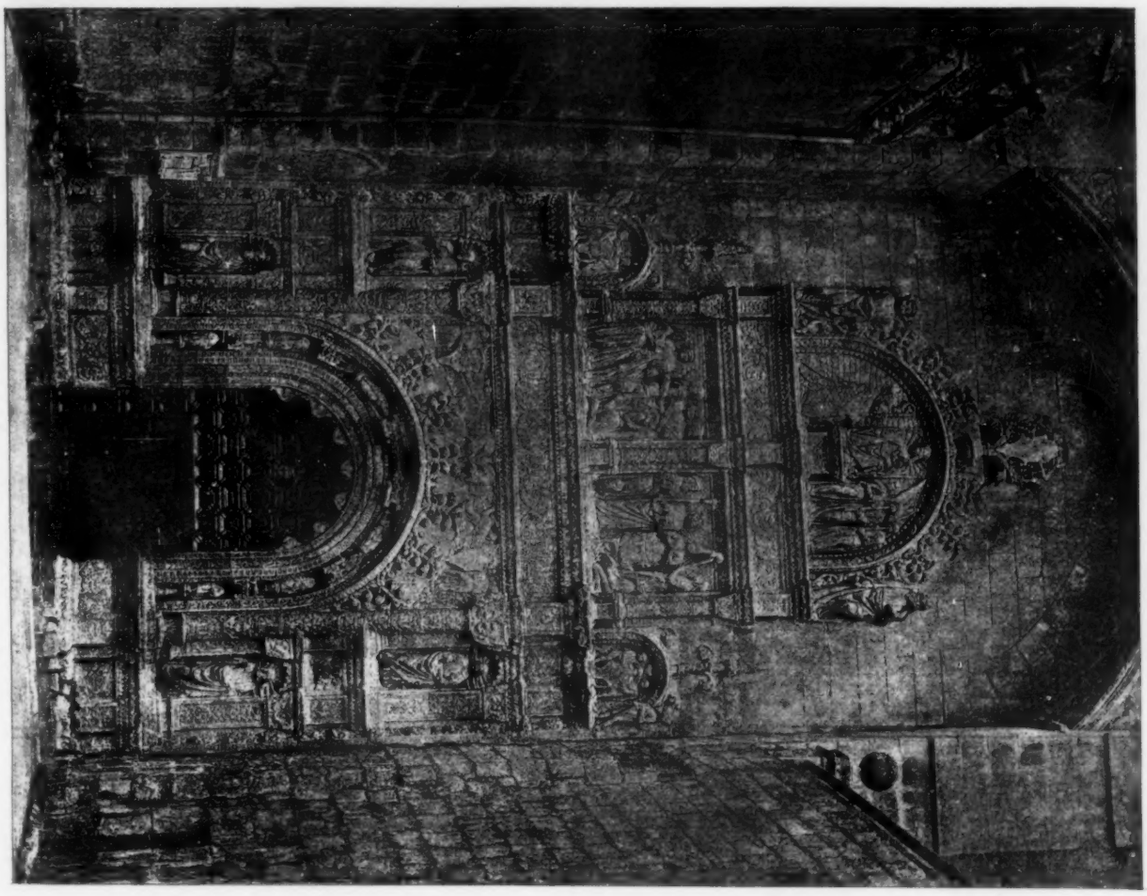
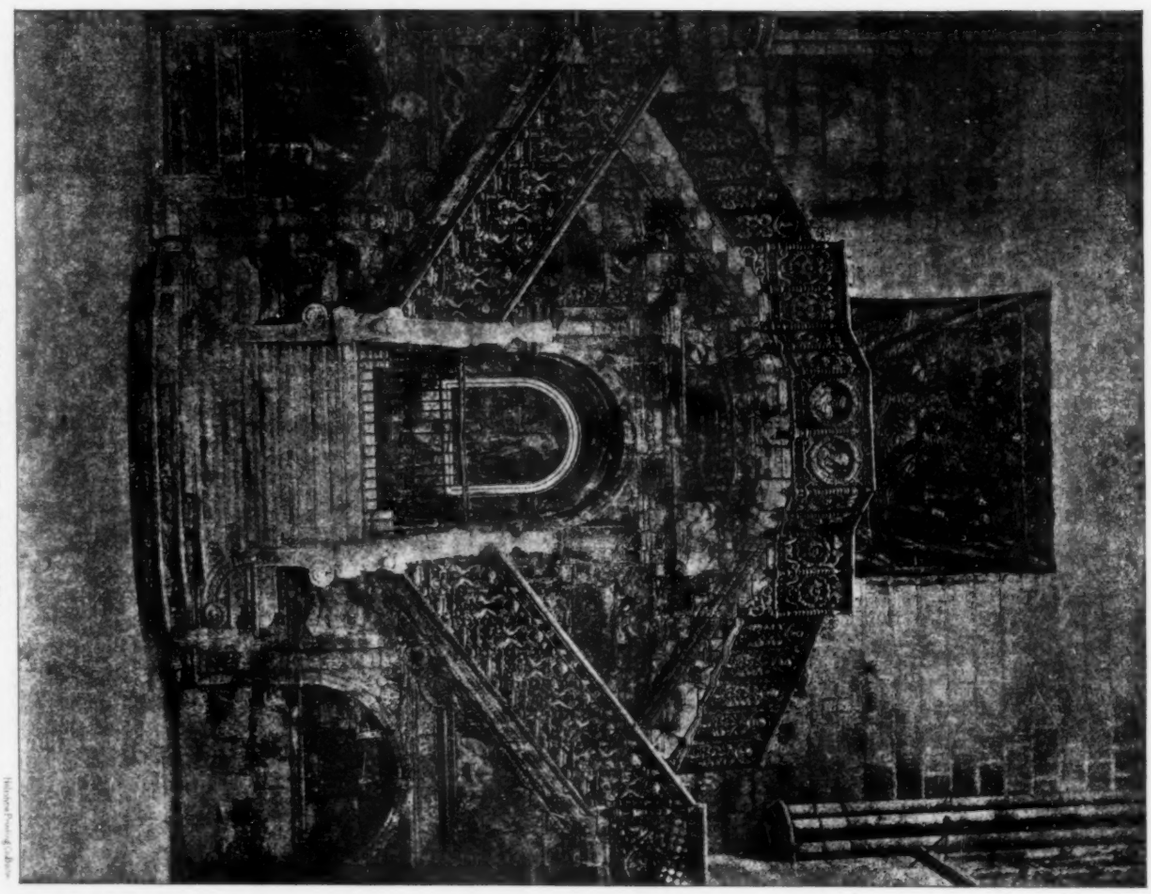


• PLATERESQUE DOORWAY • BURGOS CATHEDRAL •



• A STAIRWAY • BURGOS CATHEDRAL •

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Entrance

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